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EXOPHTHALMOS FROM SURGICAL DISEASES, ESPECIALLY AS TO INVOLVEMENT OF THE PROTECTIVE RETROBULBAR SPACE

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The bony orbit is (*a*) a goblet-shaped cone, open in front, within which, posterior to the eyeball, there is (*b*) a closed fasciomuscular space,[1] for which I would suggest the term "protective retrobulbar space;" the surgical importance of this space has not been appreciated. Overfilling of this space, even from slight circulatory alterations, which in other parts of the body gives rise to flushing and congestion, as in hyperthyroidism, here causes exophthalmos.

In suppurative and traumatic disturbances resulting from neighborhood lesions, the retrobulbar space is the most fundamental, although the least evident, element in the production of exophthalmos, for any factor outside the periorbita requires (*a*) a marked constriction of the capacity of the bony goblet-shaped bone to produce proptosis, but (*b*) slight overfilling of the protective retrobulbar space, whether it comes from the cranial cavity or from the orbital or nasal walls, will occasion exophthalmos.

Again, suppurative insult to the nervous mechanism within the space produces pathognomonic changes in the fundus of the highest diagnostic and prognostic significance, which, until now, have not been properly interpreted.

THE RETROBULBAR SPACE—THE CLOSED VISUAL SENSE-PROTECTIVE SPACE POSTERIOR TO THE EYE

The retrobulbar space, situated within the goblet-shaped bony cone of the orbit, is a special visual sense-protective space. Its function is the protection of the end-organ, the eye, against injury and from

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1. Wolff, Eugene: The Anatomy of the Eye and Orbit, London, H. K. Lewis & Co., Ltd., 1933, p. 310. Zuckerkandl, E.: Atlas der topographischen Anatomie des Menschen, Vienna, W. Braumüller, 1904, p. 107, cf. 19, 103.

infection within the neighboring respiratory apparatus. It is a closed mesoblastic space containing, however, ectodermal elements, for it develops in conjunction with that part of the special visual sense bone forming the optic foramen, the compact tissue of which in the embryo grows outward from the spheno-ethmoid cartilage attached to the special sense nasal capsule.[2] Within the space is a specific type of ligamento-muscular sling, the annulus of Zinn (annulus tendineus communis), to which the ocular muscles are attached, and which has a dural element in its composition.

This closed protective retrobulbar space (*a*) is filled with fat in an almost liquid state. In addition, it has other unique anatomic features, among which are that (*b*) there are no lymphatics in it and (*c*) its veins are without valves.

SURGICAL ANATOMY OF THE NONLYMPHATIC PROTECTIVE RETROBULBAR SPACE

The space is limited in front by (*a*) the septum orbitale and (*b*) Tenon's capsule, posteriorly by (*c*) the annulus of Zinn and laterally by (*d*) the fasciomembranous muscular cone of the orbital muscles.

The septum orbitale, or palpebral fascia, which forms the broad ligaments of the eyelids is a floating membrane firmly attached to the bony rim of the orbit. It forms a barrier to the passage of extravasations from the orbit to the lids.

Tenon's capsule—the fascia bulbi—is also a more or less "floating membrane"; it acts as an additional barrier, largely between the globe and the other contents of the orbit.[3] Both membranes can withstand considerable pressure. Substances injected (Charpy and Clermont[4]) into the retrobulbar space at a pressure ranging from 40 to 50 mm. of mercury, i. e., double the normal tension of the eye, are prevented from passing into the eyelids (Heerfordt[5]).

Lying almost loose in the lobulated semiliquid fat in the retrobulbar space are the arteries, veins and the nervous connections for the eye—the optic nerve and the ciliary ganglions, and their afferent and efferent communications.

The Valveless Venous Plexus within the Retrobulbar Space.—The orbital venous system is in reality a plexus, a network of small vessels. The upper plexus usually unites to form the chief vein of the orbit.

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2. Fawcett, E.: Notes on the Development of the Human Sphenoid, J. Anat. & Physiol. **44**:208, 1909-1910.

3. Whitnall, S. E.: The Anatomy of the Human Orbit and Accessory Organs of Vision, London, H. Frowde, Hodder & Stoughton, 1921, p. 291.

4. Charpy and Clermont: Structure topographique des paupieres, épanchements intra-palpétraux, Bibliog. anat. **2**:65, 1911.

5. Heerfordt: Ueber das Emphysema der Orbita, Arch. f. Ophth. **58**:123, 1904.

the superior ophthalmic vein, which communicates with the angular vein in front and becomes constricted at its entrance into the cavernous sinus behind. As with all venous plexuses, the connections are extremely variable, as well as the point of exit of the superior ophthalmic vein, which may perforate the annulus of Zinn or leave the orbit below, above or external to it. The vena centralis retinae, as a rule, leaves the optic nerve about 10 mm. from the globe. It opens directly into the cavernous sinus, but it may end in the superior ophthalmic vein, to which it invariably sends a good-sized anastomotic branch (Sesemann).

The lower venous system of the orbit originates in the orbital fat beneath the globe, as a still finer network; it may continue as such throughout its entire course, communicating freely with the superior ophthalmic vein, or may unite to form an interior ophthalmic vein. As a rule, it enters the cavernous sinus separate from the superior ophthalmic vein below the annulus of Zinn (Freund), but it may discharge all of its blood into the superior venous system.

Veins from the inferior ophthalmic plexus pass through the inferior orbital fissure communicating with the plexuses in the infratemporal fossa and pterygomaxillary spaces (Henle), where they, in turn, again communicate with veins from the upper and lower jaws and with the intricate plexus surrounding the condyle.[6]

Anomalies of the Veins of the Retro-Orbital Space of Surgical Importance.—(*a*) The inferior ophthalmic vein may be the chief vein of the orbit and may anastomose with the angular veins. (*b*) The superior ophthalmic vein occasionally passes directly into the sylvian vein (middle cerebral vein) without entering the cavernous sinus, in which case phlebitic meningitis may develop from an orbital infection without the cavernous sinus being affected.

(*c*) At times, the ethmoid veins empty directly into the cavernous sinus, in which event suppurative ethmoiditis may occasion cavernous sinus thrombosis—itself a very infrequent origin of the intracranial lesion and this from a suppuration outside of the periorbita without involvement of the retrobulbar space.

INFECTION OF THE RETROBULBAR SPACE

Routes of Infection into the Protective Retrobulbar Space.—Thus, anatomically, the retrobulbar space can become infected by endophlebitis coming (*a*) from in front, by way of the superior ophthalmic plexus, (*b*) from below, from the pterygoid plexus or through the inferior ophthalmic plexus, or (*c*) mesially, from the nose. Endophlebitis of the vessels within the space (*a*) may remain thrombophlebitis of one or the other of the ophthalmic veins (case 2) or it (*b*) may form a

6. Poirier, P., and Charpy, A.: Traité d'anatomie humaine, Paris, Masson et Cie, 1903, pp. 932 and 946.

local abscess within the cone, although infection of the retrobulbar space (*c*) usually is but a part of a generalized orbital phlegmon.

A suppurative lesion of the space usually occasions (1) cavernous sinusitis with (2) terminal meningitis. However, the infection of the space itself may arise secondarily from cavernous sinus phlebitis (cases 4 and 5).

Clinical Evidences of the Protective Properties that the Orbital Tissues Possess for the Control and the Prevention of Spreading Infections.—Clinical facts of the greatest surgical significance are that (*a*) enucleation of the eyeball never results in an actively spreading phlegmon, no matter with what lack of asepsis the operation may have been performed, and that (*b*) transplants of fat buried within the orbit invariably heal favorably, although the graft cannot be absolutely aseptic. Furthermore, (*c*) both of the foregoing occur without lymphatics, which in other subdermal tissues containing fat are the chief protective mechanism in the elimination of infection.

The Protective Forces within the Orbit Against an Infection of the Retrobulbar Space.—Anatomically, passive protection against infection from the face is furnished by (*a*) the delicate but effective fascia orbitopalpebralis and Tenon's capsule, but I believe that it is (*b*) the active local phagocytic elements furnished by the reticulum of the retrobulbar space and (*c*) the digestive action of the semiliquid fat contained within the reticulum, both within and external to the space, that are the chief factors in this immunity (Hartwell [7]).

Clinical Evidence that Widening of the Retrobulbar Space by Surgical Decompression Relieves Exophthalmos.—In reviewing the literature, one is struck by the number of cases in which exploration by means of Krönlein's osteoplastic operation for a supposed tumor (diagnosed as such because of the presence of exophthalmos) revealed no pathologic process. Nevertheless, the operation resulted in the return of the eye to its normal position (Königstein [8]).

This can be accounted for only on the basis of decompression of the bulbar space, as such recession does not occur after multiple punctures around the eye.

A Specific Type of Infection of the Retrobulbar Space Differing from the Ordinary Orbital Phlegmon.—The specific type of infection to which I call attention is those cases of orbital phlegmon, almost invariably associated with cavernous sinus phlebitis, in which (*a*) the

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7. Hartwell, S. W.: Surgical Wounds in Human Beings: Histologic Study of Healing with Practical Applications; Fibrous Healing, Arch. Surg. **2**:76 (July) 1930.

8. Königstein, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4855.

veins are the mode of transmission of the infection, and (*b*) the vessels within the fasciomuscular retrobulbar cone are involved.

The Ordinary Orbital Abscess Resulting from Nasal Suppuration Not of Phlebitic Origin.—Usually, an orbital abscess resulting from suppuration of the ethmoid sinus is (*a*) localized tissue suppuration situated (*b*) external to the periorbita. Neither the veins nor the retrobulbar space is involved, although the latter may be the seat of a reactive edema, thus materially augmenting the exophthalmos.

Discovery of the Unique Character of the Ophthalmoscopic Picture from Infection Confined to the Retrobulbar Space and Its Disappearance Following Orbital Decompression.—In rereading the histories of my cases of cavernous sinus infection, of which I now have seen thirty-eight, I was struck by (*a*) the frequency with which the vision of the affected eye had suddenly been diminished; examination of the fundus showed (*b*) whiteness of the nerve, (*c*) obliteration of the retinal artery and (*d*) dilatation or no change in the veins. Associated with these symptoms, several records reveal (*e*) inequality of the pupillary reactions and (*f*) early steaminess of the cornea, the latter being out of proportion to the slight degree of the exophthalmos that was present.

At the time, I had attributed the change in the fundus to the lodgment of emboli in the arterial supply to the eye from a clot in the cavernous sinus. However, the ophthalmoscopic picture was not that of an embolic occlusion of the central retinal artery in that, while the disk was whitish, the retinal tissue itself was not edematous and there was no mention in any of my notes of the presence of a cherry-colored ring around the macula; nor was it the picture of thrombosis of the retinal vessels, because of the absence of hemorrhages in the fundus.

In one case of cavernous sinus phlebitis (case 5), sudden blindness (with a whitish nerve head and constricted arteries) was the first really alarming symptom, the patient having been working but a few hours previously. The exophthalmos at the time of the onset of blindness was very slight. Immediately after his death, the following day, examination of the orbital contents disclosed a localized area of purulent inflammatory infiltration which was confined within the fasciomuscular cone of the apex.

Again, in a case of extradural abscess which was situated above the optic nerve and which followed a fracture through the optic plate of the frontal bone, there was whiteness of the nerve head with constricted arteries the day after the fracture. The preoperative diagnosis (Dr. John V. Bissett) was "hemorrhage into the optic nerve sheath," a condition which I[9] have previously described and for which I have

9. Eagleton, Wells P.: Fracture of the Skull: Importance of Early Diagnosis and Operative Treatment, Arch. Surg. **3**:140 (July) 1921; Brain Abscess, New York, The Macmillan Company, 1922, p. 169.

operated with a moderate degree of success in several cases. At the operation hemorrhage into the sheath was not found, but decompression of the orbit by the removal of depressed bone and the evacuation of hemorrhagic clots was immediately followed by return of the circulation to the fundus and restoration of vision (case 1).

CASE 1.—*Whiteness of nerve head from depressed fracture of the orbit relieved by elevation of the fracture* (Dr. John V. Bissett, Newark City Hospital).

History.—A young girl, S., was struck by an automobile and suffered a compound depressed fracture of the frontal bone involving both orbits. The fracture extended across the nose. The entire orbital roof was loose. The following day the optic nerves were white. Hemorrhage in the optic nerve sheath was thought to be the cause of the whiteness of the nerve of the right side.

Operation.—The brain was elevated over the orbital plate. The fracture was seen extending posteriorly over the orbital plate, apparently entering the orbital foramen.

The day following the operation the whiteness of the nerve had disappeared. The child did well for several days; then pneumonia developed, with a stiffness of the neck; the patient suddenly went into a state of coma and died. The cerebrospinal fluid contained streptococci.

Autopsy.—A fracture was seen extending through the entire orbital plate on the right side, across the cribriform plate and over the orbital roof; there was also a fracture of the great wing of the sphenoid bone on the left side.

The orbital plate on the right side was loose. There was extradural hemorrhage with an extradural abscess in this region. There was no hemorrhage into the sheath. There was a marked constriction where the optic nerve passed through the optic foramen. It was difficult to dissect the nerves away from the bone. There was greatly increased intracranial pressure. However, during life there had been no papilledema or injection of the veins at the fundus. The whiteness of the nerve was thought by Dr. Harrison Martland to be due to an "arterial coma" from a paralyzing influence of the sympathetic nerve, which caused obliteration of the arteries.

Phlebitis Confined within the Retrobulbar Space Surgically Analogous to Ludwig's Angina.—Surgically, isolated infection of the retrobulbar space is analogous to Ludwig's angina, as it is an acutely extending infection situated within unyielding tissue. In the case of Ludwig's angina, the infection is confined between two fascial planes, the weaker yielding to swelling, causing elevation of the tongue; in infection of the retrobulbar space, swelling posterolaterally is prevented by the bone of the orbit. Thus, the eye must be moved forward, carrying with it Tenon's capsule. In infection of the retrobulbar space, as in Ludwig's angina in the early stage, there is no pus, the tissues being infiltrated with serum. However, pressure and the virulence of infection rapidly cause extensive necrotic sloughing of tissues (case 5), prior to which the nervous mechanism controlling the intra-ocular circulation reacts uniquely. The sudden septic insult to the exposed ciliary ganglions and to the vasa vasorum on the ophthalmic artery causes a

stupeur artérielle of the ophthalmic artery, thus giving rise to (*a*) sudden diminution or loss of vision, associated with (*b*) whiteness of the nerve head and (*c*) contraction of the arteries of the fundus, its veins being lightly affected. The latter is probably because the return circulation from the eye is free, passing anteriorly into the facial system as well as posteriorly into the retrobulbar space.

Rapid Formation of Abscess in Retrobulbar Space.—A stage of serous effusion within the space cannot long continue, as the valveless veins, having no adventitious coat, break down with the formation of an abscess, the usual method by which nature localizes vascular infections in all well protected areas.

CASE 2.—*Rapid orbital necrosis without abscess formation from a phlebitic infection largely confined to the retrobulbar space, associated with fulminating purulent phlebitis of the cavernous sinus from a stye on the eyelid* (Drs. Henry C. Barkhorn and John V. Bissett).

History.—A boy, W., on November 24 had a stye on his right eye, which after five days opened spontaneously and disappeared on November 29. On December 6 he had an earache on the right side. However, the examination of the drum gave negative results. On the following day the right eyelids became swollen. On the next day (December 8) there was proptosis.

Ocular Examination.—The lid of the right eye was greatly swollen, the tissue around it being swollen and edematous. There were considerable proptosis and slight chemosis. The ocular conjunctiva contained in the outer corner a large number of veins running parallel with the long axis of the orbit. The lids of the left eye also were slightly swollen, and there was slight chemosis.

Examination of the Fundus.—(*a*) The right disk was absolutely white. (*b*) There were no arteries to be seen. (*c*) The veins, however, were full. (*d*) There was a slight haziness of the cornea. The left fundus presented a similar condition, but not as marked; that is, there were white nerves, small arteries and congested veins.

Course.—There was rapid terminal cerebral edema. During the day the child had six convulsions. After the first convulsion his temperature reached 105 F., and it remained high until his death.

The leukocytes numbered 19,000. The blood culture showed Staphylococcus aureus. (Smear and culture from the right eye showed Staph. aureus.)

The boy died the same day, three days after the beginning of acute symptoms and ten days after the onset of the original stye infection.

Autopsy.—The base of the skull showed general edema around the veins. There was general distention of all the veins of the base. The pituitary region and the olfactory nerves were edematous. The ophthalmic nerve on the right side was more edematous than that on the left. There were small hemorrhages in the dura of the region of the right middle fossa. The right cavernous sinus was edematous, more so than the left. When the right cavernous sinus was opened, its anterior extension was found to contain pus.

On the left side the anterior extension of the cavernous sinus also contained more pus than that on the right side. Running along the floor of the middle fossa

there was what looked like an anterior cavernous sinus, which had opened and contained a clot with many bands in it, the same as were seen in the cavernous sinus. The carotid artery on the left side was more edematous than that on the right. The floor of the left middle fossa showed pus under the dura.

Comment.—The disease, coming from in front, apparently extended a little farther backward into the superior petrosal sinus on the left than it did on the right side.

Purulent Thrombophlebitis of the Ophthalmic Vein.—The right orbit, opened from behind, macroscopically showed no cellulitis, edema or free pus, but there was grumous pus in the ophthalmic veins. A smear of the specimen from the right orbit showed Staph. aureus. The left orbit showed the same condition as the right, excepting that the ophthalmic vein was smaller. Smear of the specimen from the left orbit also showed Staph. aureus.

Microscopic examination of a section of the ophthalmic veins showed "suppurative thrombophlebitis" (figs. 1 and 2). The orbital fat on the right side presented the microscopic picture of suppuration (fig. 3). The orbital fat on the left side showed necrosis.

CASE 3.—*Rapid development of whiteness of the fundus in a case of fulminating cavernous sinus phlebitis; meningitis from a pimple on the nose and nasal sinusitis.*

History.—A young boy, R. (seen in consultation with Dr. J. Reiner), on November 8 had a sore area on the tip of his nose and a cold in his head. On the following day he vomited and had a headache.

Two days later he complained of a severe throbbing headache and was nauseated; he had a temperature of 101 F. and a rapid pulse. There were no distinct chills, but he felt chilly. On November 15 (one week after he had the pimple on his nose) there was slight redness of the upper lid of the left eye, and the severe headache returned. His temperature rapidly rose to 104 F.

On the following day (November 16) the left eye was completely closed, with redness and swelling of the upper lid, and there was a slight exophthalmos. The vision rapidly failed.

Examination.—The left disk was paler than the right. The veins of both fundi were full, but those of the right disk were very full and tortuous. During the day the vessels of the left fundus grew progressively paler.

Roentgen examination showed cloudiness of the left frontal and ethmoid sinuses and antrum. The condition was considered to be beginning suppurative meningitis from fulminating cavernous sinus phlebitis and pansinusitis.

Operation.—Primary ligation of the common carotid artery was performed with fascia lata. The left orbit was eviscerated, and the cavernous sinus was incised and drained, with slight bleeding. Culture of the pus from the frontal sinus showed streptococci and Micrococcus catarrhalis.

Course.—On admission to the hospital the boy complained of double vision; he had a stiff neck, and a Kernig sign was elicited. Lumbar puncture showed 1,700 cells, and a reduced amount of dextrose. General meningitis rapidly developed.

Death followed meningitis and venous sepsis, with a terminal infarct into the lung. There was a loud systolic murmur over the heart.

CASE 4.—*Fundus signs of arterial strangulation in one eye and venous obstruction in the opposite eye from a fulminating cavernous phlebitis and meningitis.*

Fig. 1 (case 2).—Low power photomicrograph in a case of suppurative thrombophlebitis of the ophthalmic vein, showing colonies of bacteria.

Fig. 2.—High power magnification of the section shown in figure 1. One colony of bacteria is seen.

History.—A young man, E., ten days before examination had a pimple on the left side of his nose. His nose was not sore, but he had chills. He thought he had "a cold." On the second day, Sunday, he was quite ill; the temperature was around 101 F. The swelling of the nose increased, extending to the lid of the left eye. On Friday the swelling passed to the lid of the opposite eye. The temperature rose to 104 F. and 105 F. and he had a very rapid pulse. That night (Friday), one week following the onset of the illness, the patient became delirious.

At the time of my examination, the following Monday, he was semicomatose, moaning constantly; he had a stiff neck and the facial cyanosis of profound toxemia. He was manifestly dying of terminal meningitis.

Ocular Examination.—There was bilateral exophthalmos, which was much more marked in the right eye—the one secondarily involved—than in the left eye.

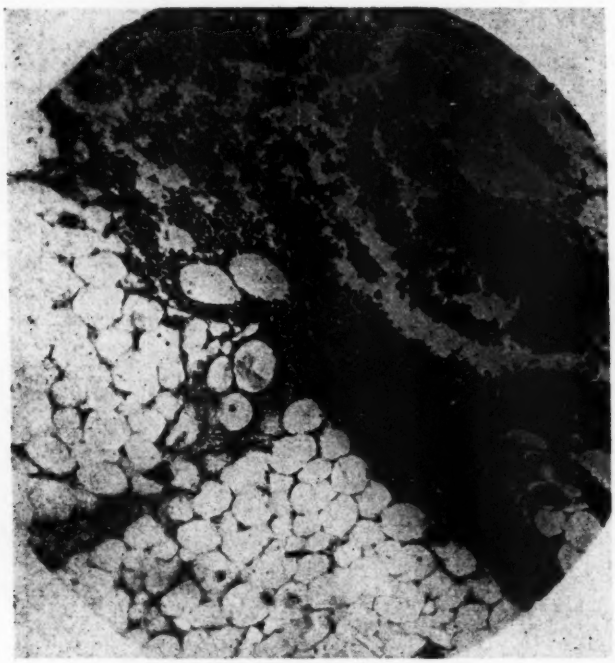

Fig. 3.—Low power photomicrograph showing suppuration thrombophlebitis of the ophthalmic vein; orbital tissue (left) and extensive microscopic suppuration.

The veins in the lids were dilated and tortuous. There was a bluish-black chemosis of the right conjunctiva. The eyeball was fixed. The fundus of the right eye showed edema around the nerve. The veins on the disk were blackened, but no arteries were present. The picture was that of strangulation of the arterial system.

The left lids were edematous with moderately dilated veins. There was a slight chemosis of the left conjunctiva. The pupil was small. The veins of the fundus were black and very prominent—the picture of venous obstruction.

Impression.—It would seem from the history that the infection passed from the left facial vein into the left ophthalmic vein causing obstruction but not a complete blockage of the venous return. It then rapidly extended from the left orbit into the cavernous sinus and entered the right orbit, where it is now causing death of the tissue.

The Surgical Importance of the Phlebitic Character of the Orbital Phlegmon.—In a phlebitic orbital phlegmon there is a peculiar blueness of the vessels of the conjunctiva, many of which run parallel with the globe (case 2). In such a case the usual exploration for a pocket of pus by multiple punctures outside or inside (Butler [10]) of the muscular cone or after the division of one or both tarsal ligaments (Lawson and Tweely [11]), in my experience has but too frequently converted a semiquiescent phlebitic infection into an actively advancing one.

CASE 5.—*Sudden blindness with whiteness of the fundus from a retrograde invasion of the retrobulbar space followed by a fulminating cerebral sepsis,*[12] *the result of subacute cavernous sinus thrombophlebitis with but slight symptoms from a stye of the eyelid.*

History.—A middle-aged man, G., had a stye on his right eyelid. Four days later (April 28) the muscles of his neck felt stiff and he had some difficulty in swallowing, but he continued to work. While the stye on the right lid was "doing well," the left lid became slightly swollen and sore.

On the following day (April 29), although the patient's temperature was 101 F., he felt well and returned to work.

On April 30 he had violent pain in the left side of his head. He was seen by his physician (Dr. E. S. Goudy) at 5 o'clock in the afternoon, at which time the patient made no complaint of the condition of the eye, and the swelling of the lid was so slight as to escape attention. Two hours later (7 p. m.) he suddenly lost the sight of the left eye, and the pain in his head progressively became worse. By the time of my examination at 8 o'clock there were a bilateral exophthalmos, which was slight in the right eye but marked in the left, slight chemosis in the lower part of the conjunctiva and beginning haziness of the left cornea.

Examination of the Fundi.—The left fundus showed general whiteness, as if the blood supply was almost absent. However, beyond the disk one vein was markedly dilated. The right fundus was normal.

Course.—The patient passed into a state of coma and died twelve hours after the onset of blindness and seven days after the primary infection (stye).

Autopsy.—There was pus in the anterior end of the left cavernous sinus, which contained a clot extending from the left cavernous sinus through the posterior and anterior circular sinuses into the right cavernous sinus. There was slight hemorrhage about the left carotid artery and left anterior clinoid process.

Orbits: The left orbit was edematous, with hemorrhagic infiltration of the muscles and of the retrobulbar tissues behind the eye. The same condition was present on the right side but was less marked.

Sphenoid Sinuses: Small blood clots were found in the sphenoid sinuses, but there was no pus.

Brain: The meninges showed no signs of inflammation, but there was moderate dilatation of the veins of the pia mater, and the cortex of the brain was flattened from increased intracranial pressure.

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10. Butler, T. Harrison, in discussion on Trotter, W.: Diagnostic Significance of Proptosis, Tr. Ophth. Soc. U. Kingdom **43**:206, 1923.

11. Lawson, George, and Tweely: Plastic Cellulitis of the Orbit, Tr. Ophth. Soc. U. Kingdom **15**:186, 1895.

12. Eagleton, Wells P.: Cavernous Sinus Thrombophlebitis, New York, The Macmillan Company, 1926, p. 29, case 11.

Differentiation Between Exophthalmos Resulting from Erysipelas and a Phlebitic Orbital Phlegmon.—Formerly I was unable to distinguish between exophthalmos resulting from beginning erysipelas and a phlebitic orbital phlegmon. Today I am inclined to regard any proptosis as significant that the infection is deeper than the skin in which the erysipelas streptococcus travels. It is further my belief that those cases of proptosis that subsequently develop into erysipelas are primarily phlebitic phlegmon in which the streptococcus causing the phlegmon has been transmuted into erysipelas, for it is now recognized that streptococci from scarlet fever erythematosis of the skin may be transmuted with resulting phlegmonous cellulitis, or even osteomyelitis.

CASE 6.—*Relief of exophthalmos in the homolateral eye and restoration of vision following blindness, with white disk and obliteration of retinal arteries in the contralateral eye from retrobulbar phlegmon by ligation of the carotid artery. Complications of purulent cavernous phlebitis from extensive phlegmonous gangrene of the head, the result of a carbuncle of the nose.*

History.—A young man (seen with Dr. S. A. Cosgrove) on November 25 had a "pimple" on the left side of his nose which was incised. On the following day he worked but felt rather sick. He returned to work the next day (November 27), during which time he had a chill and his face began to swell. The chill recurred. Two days later exophthalmos of the left eye appeared.

General Examination (December 1).—The patient was conscious and answered questions intelligibly, but his temperature was 106 F. There was a gangrenous carbuncle of the nose which had points of gangrene and hemorrhagic areas in it. Little areas of gangrene had extended over his face, and red lines ran into the scalp, which was the seat of an edematous infiltration involving both sides of the neck.

Ocular Examination.—The left globe was bulging extremely. The pupil was small. The eye was blind.

Examination of the Fundi: The disk of the left fundus was almost white, with only one vessel above and one below it. I could not tell whether they were veins or arteries.

The right eye was also proptosed, and there was chemosis, but it was not so marked as in the left eye. At this time the right fundus did not show any indistinctness of the margin of the disk, but the vessels were small and the veins were not overlarge.

Vision of right eye was normal, as the patient could see objects well.

However the changes in the fundus progressed rapidly with the involvement of the right retrobulbar space, and three hours later he was totally blind in his right eye, as well as in his left; the right fundus now gave the same appearance as the left had three hours previously.

Operation.—An incision was made in the neck and all the tissues were found to be juicy. The left external and internal carotid arteries were ligated just above the bifurcation, with ligation of the first ascending branch of the external carotid artery. This had an immediate effect on the exophthalmos of the left eye, which receded perceptibly. The left orbit was eviscerated, and the cavernous sinus was drained.

Restoration of Vision of the Right Eye (opposite to carotid ligation).—Following the operation the man was able to count fingers promptly with his right eye.

Subsequent Course.—Symptoms of pneumonia rapidly appeared; there was pain in the side of the chest, and the patient expectorated bloody sticky sputum. The leukocyte count was 7,000, with 85 per cent polymorphonuclears.

The patient died of cardiac failure on the following day, seven days after the beginning of the "pimple" in his nose, five days after the first chill and three days after the appearance of exophthalmos. His death was undoubtedly due to pneumonic involvement by septic infarcts and not to meningitis from the cavernous sinus, as there was no stiff neck or Kernig sign, and he was conscious to the end.

Autopsy.—Base of Skull: The whole of the median area of the middle fossa had multiple small hemorrhages in the dura and hemorrhage into the pituitary. The vein that runs forward along the floor of the left middle fossa was enormously engorged and raised, while the corresponding vein on the right side appeared flat

Fig. 4 (case 6).—Photomicrograph from a case of suppuration in retro-orbital tissue and pyogenic retro-orbital infection, showing cellular infiltration.

and empty. The lateral veins of the left middle fossa were much larger than those of the right side.

Cavernous Sinuses: The left cavernous sinus was fuller than the right. Its cavity was filled with grumous clot but contained no pus. The outer end of the left superior petrosal sinus was free, there being a distinct line of demarcation where it entered the cavernous sinus. A vein running along the small wing of the sphenoid bone was very large and thrombosed. The right cavernous sinus also contained a grumous clot. The right carotid artery in the cavernous sinus was thickened and softened.

Orbit: The tissues of the right orbit were juicy (figs. 4 and 5). The right ophthalmic vein was apparently thrombosed. The left ophthalmic vein also contained a clot. The enucleated eye was free from disease (fig. 6).

Accessory Sinuses: The sphenoid sinuses contained bloody secretion.

Brain: The brain was whitish from pressure.

Ganglionic Origin of Whiteness of the Nerve Head and Obliteration of the Arteries in Infections of the Retrobulbar Space.—It has long been known that the immediate effect of traumatism to the brain is accompanied by whiteness of the disk. This is followed on the next day by congestion of all the vessels. The whiteness of the disk is (probably) due to a "spasm of the arteries" from the trauma to the central mechanism of the sympathetic nervous system around the third ventricle of the brain. The arterial spasm has been named "arterial coma," or *stupeur artérielle* (Leriche).

Acute bacterial insult from a venous infection within the intramembranous muscular cone, well posterior to the eyeball, apparently

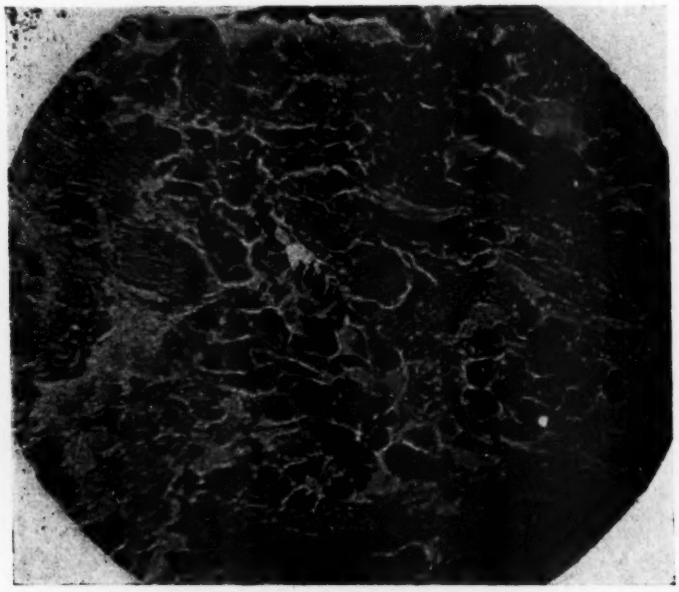

Fig. 5 (case 6).—High power magnification of the section shown in figure 4.

occasions a similar arterial spasm, for I believe that it is demonstrated from the postmortem examination in cases 2, 5 and 6 that the contracted retinal arteries with associated blindness and whiteness of the nerve, while apparently of arterial origin, were primarily due to a venous infection within the retrobulbar space situated so far posterior to the eyeball that the venous circulation from the retina was not affected. Certainly the arterial symptoms appeared coincident with a sudden septic thrombophlebitis of the retro-orbital veins.

An anatomic explanation is that the fundus picture is primarily due to the insult to the exposed nervous mechanism contained within the ciliary ganglions, the nervous mechanism reacting by contracting the ophthalmic artery.

Pupillary Changes from Involvement of the Ciliary Ganglion in Infections of the Retrobulbar Space.—That the disturbance is due primarily to the nervous system and not to the vascular system is shown by the effect on the pupil, as in cases 4, 7 and 13. The pupil was small on the side of the irritation of the ciliary ganglions in cases 4 and 7, although it reacted consensually following ligation of the common carotid artery, which it did not do before, and the patient could open his eye after ligation.

The ophthalmoscopic picture accords with the picture seen in cases of sudden blindness following trauma from operation on the nose (Würdemann [13]) and following injections of paraffin.

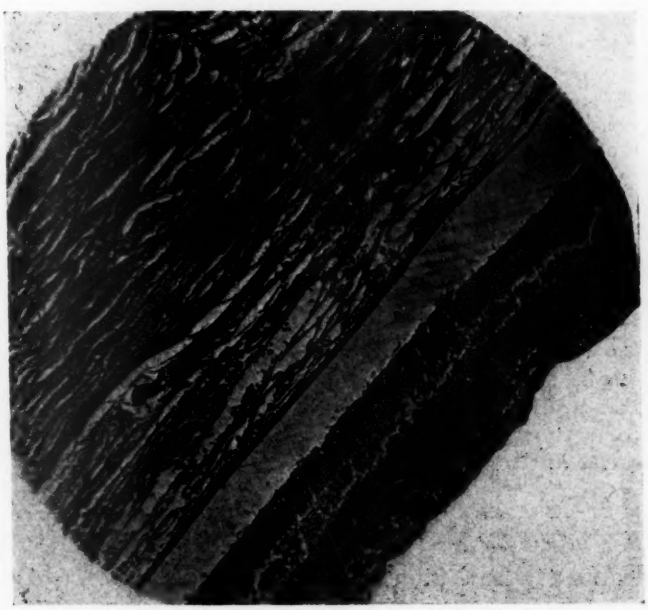

Fig. 6 (case 6).—Enucleated eye free from disease.

The arterial spasm is undoubtedly a protective reaction. Consequently, I think that in infection of the retrobulbar space prompt drainage of the bacterial irritation should relieve the arterial spasm and restore the vision, as in case 6, in which venous congestion was relieved by ligation of the opposite carotid artery, although the lesion in the orbit must have continued, and also as in case 1, in which the whiteness of the fundus disappeared after the relief of pressure from a fracture.

CASE 7.—*Exophthalmos with blindness and retinal vascular obliteration caused by nasal operation with subsequent contraction of the pupil.*

13. Würdemann, H. V.: Injuries of the Eye, Chicago, Cleveland Press, 1912, p. 205.

History.—A boy (seen in consultation with Drs. L. Peer and Lee Hughes) had chronic bilateral sinusitis. The opening by a competent physician of the right posterior ethmoid cells, the bone of which was abnormally hard, was immediately followed by protrusion of the right eye. On coming out of the anesthesia the patient was blind.

On the following day there were swelling of the lids, with ecchymosis, marked exophthalmos, slight chemosis, complete paralysis of the third nerve, with ptosis, and a widely dilated pupil. He had no perception of light. At first the fundus had been normal, but during the examination it gave the picture of a vascular occlusion; the arteries were very small and were "kinked" over the disk. The veins also were very small. The patient was now able to recognize movements of the hand.

Diagnosis.—A diagnosis was made of fracture running through the orbit and optic foramen.

Operation.—Under local anesthesia, the right common carotid was ligated with fascia lata. When the ligature was tightened, there immediately was some recession of the eye, and the patient was able to elevate his lids.

Ether was then administered, and a modified Krönlein operation was performed, the removal of bone being continued as far back as possible, followed by a vertical incision through one of the muscles. The orbital tissue was not under great tension. The optic nerve was freed. The passage of a hook under the optic nerve liberated a few clots of old blood. The optic nerve was not swollen. A small incision was made in it.

The operation had no effect on the vision or on the paralysis of the third nerve, but the exophthalmos immediately disappeared.

Subsequent Peculiar Pupillary Reaction.—Several months later the right pupil was found to be smaller than the left. "It would seem as if the smallness of the pupil must be due to an injury of the ciliary ganglions—certainly not to the injury to the sympathetic nerve in his neck." The fundus showed an area of blackish pigment in the macular region.

Comment.—The early haziness of the cornea in case 2 was also probably due to involvement of the ciliary ganglion. In case 13 not only was there an interstitial keratitis, but the next day the patient had a low intra-ocular pressure.

In case 13 the hemorrhage into the conjunctiva was probably embolic infarcts, as there was albumin in the urine. In my experience hemorrhages ordinarily do not occur in the retina in cases of cavernous sinus thrombophlebitis.

The fixation of the ocular muscles is probably due to the inflammatory exudate (case 4).

INFLUENCE OF AURAL SUPPURATION

Cavernous Sinus Thrombosis Resulting from Aural Suppuration, Presenting Arterial Symptoms Following Acute Invasion of the Retrobulbar Space.—The acute orbital phlebitis causing exophthalmos is usually part of a phlegmon from a phlebitic infection of the nasal orifice, the eyelids and the lip. In the fulminating cases it may be associated with an extensive streptococcic erysipeloid infection of the

skin (case 6). The acute phlebitis cases invariably terminate in cavernous sinus phlebitis, complicated by an almost simultaneous meningitis.[14]

This type of diffuse phlebitic phlegmon must be recognized surgically as a different pathologic lesion from the slowly progressive low grade compensatory thrombus due to infection of the middle ear which enters the cavernous mesh from behind by way of the petrosal sinuses. The former is a diffuse endophlebitis of the small vessels, the latter, a more or less localized abscess surrounded by a limiting clot within a large venous radicle. Either lesion, however, may cause *stupeur artérielle* by the sudden entrance of the infection into the protective retrobulbar space.[15]

Exophthalmos in Infections of the Posterior Part of the Cavernous Sinus the Result of Aural Suppuration.—In the cases of compensatory thrombosis of the cavernous sinus originating from a suppurating ear, exophthalmos is usually slight in degree and is apt to be of transient duration, because (*a*) the collateral venous return from the orbit is soon reestablished and (*b*) the venous stasis, which is the chief cause of the exophthalmos, rapidly subsides.[16]

I herein summarize five cases of subacute compensatory thrombotic venous infection from aural suppuration, three of which (*a*) retrograded through a petrosal sinus and involved the cavernous sinus, one (*b*) attacked the cavernous sinus directly from a diffuse suppuration of the bone marrow within the petrous apex, and another (*c*) originated from suppuration of the cavernous and of the sphenoid sinus. The exophthalmos and chemosis in all were characterized by being (*a*) slight in degree and (*b*) of transient duration. All were (*c*) unaccompanied by any change in the arterial blood supply of the retina.

CASE 8.[17]—A. W., a child, some time after an operation for mastoiditis, had a "dark blue" eye,[18] and complained of pain in the eye. Suddenly, she became maniacal, and paralysis of the external rectus muscle developed with other symptoms of petro-apical infection.

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14. Eagleton, Wells P.: Suppurative Meningitis of Otitic and Nasal Origin, Arch. Otolaryng. **15**:885 (June) 1932.

15. Kolb reported a case of white disk resulting from a thrombosis that was evidently aseptic, as the patient had no rise in temperature during three months of illness (Ein Fall von Hirnsinusthrombose, Berl. klin. Wchnschr. **13**:663, 1876).

16. Eagleton, Wells P.: The Carotid Venous Plexus as the Path of Infection in Thrombophlebitis of the Cavernous Sinus, Arch. Surg. **15**:275 (Aug.) 1927.

17. Eagleton, Wells P.: Unlocking of the Petrous Pyramid for Localized Bulbar (Pontile) Meningitis Secondary to Suppuration of the Petrous Apex, Arch. Otolaryng. **13**:386 (March) 1931, case 4.

18. Alexander, S.: Otogenic Thrombophlebitis of the Cavernous Sinus, Monatschr. f. Ohrenh. **59**:971, 1925.

Ligation of the carotid artery on the side of the mastoiditis and the evacuation of a granulomatous mass from the apex permanently cured the patient.

In this case I am of the opinion that acute venous congestion was the cause of the transient blueness around the eye, as I have seen all symptoms of suppuration of the petrous apex promptly subside after a ligation of the carotid artery alone.[19]

Case 9 (Dr. E. A. Curtiss.[20]).—A young boy, G., had infection of the jugular bulb which extended into the cavernous sinus and occasioned suppuration in the petrous apex and an abscess around the carotid artery. During the course of the pyemia, he had two attacks of transient exophthalmos with but little or no chemosis. Both subsided within a few hours. Proptosis first appeared on October 2, at which time the cavernous sinus probably was attacked, and recurred on October 7, when the sinus was completely obliterated. The patient died of septic meningitis on November 3, without exophthalmos or other evidence of venous congestion. The microscopic section showed an organized blood clot in the cavernous sinus, demonstrating the reparative process that may occur in one month's time in a large venous trunk.

Case 10.—An elderly woman, P.,[21] had so few symptoms from the infection in her ear that she was thought to have pneumonia, when in reality she was suffering from a chronic sinus thrombophlebitis due to Str. mucosus (Pneumococcus type III). The suppurative process gradually extended into the jugular bulb, then retrograded through the inferior petrosal sinus into both cavernous sinuses.

The day before the patient became unconscious from terminal meningitis slight exophthalmos and chemosis appeared; postmortem examination showed that blocking of both cavernous sinuses had existed for some time.

Here the obstruction of the venous return from the orbit took place so slowly that all signs of venous congestion were absent until terminal meningitis augmented the general stasis by further interfering with the venous return from the anterior part of the head.

Case 11.—A middle-aged woman, C., was taken sick on November 16 with a "cold in her head and chest." She had a buzzing in her left ear, with but little pain and no discharge. She became delirious, which condition was relieved by a spontaneous aural discharge. Following an operation on the mastoid, she left the hospital as cured.

On January 9, one month following the operation, she came to the clinic of the Newark Eye and Ear Infirmary with a slight proptosis of her left eye. The next day the exophthalmos disappeared. Subsequently, an operative trauma caused a recrudescence of a diffuse but latent osteomyelitic phlegmon within the substance of the marrow of the apex, associated, as it is apt to be, with suppurative meningitis.

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19. Eagleton, in discussion on Vail, H. H.: Vidian Neuralgia with Special Reference to the Eye and Orbital Pain in Suppuration of the Petrous Apex, Tr. Am. Otol. Soc. **22**:117, 1932.

20. Eagleton,[12] p. 148, case 24.

21. Eagleton,[12] p. 38, case 13.

At autopsy, both cavernous sinuses were found filled with pus, although there had been absence of proptosis and of all other evidence of venous stasis from the time of the invasion of the sinus several weeks previously.

CASE 12.—A man suffered from an acute infective cavernous sinus thrombosis complicating otitis media and suppuration of the sphenoid sinus. During the third week of his illness and two days prior to his death from general sepsis, slight ocular edema appeared.[22]

INTERMITTENT EXOPHTHALMOS

A few cases of intermittent exophthalmos have been reported. In Colombo's case [23] the exophthalmos was associated with a suppurative otitis and recurred with each successive attack, but as the ocular protrusion could also be produced by pressure over the right jugular vein or by turning the head to the right, and as it persisted after the aural suppuration had subsided, the intermittent proptosis was doubtless due not to infection but to a congenital anomaly of the vessels returning the venous flow from the orbit.

TEMPORARY EXOPHTHALMOS AND CHEMOSIS FROM CONTINUED PRESSURE ON THE OPPOSITE JUGULAR VEIN DURING AN OPERATION FOR SINUS THROMBOSIS, THE RESULT OF AURAL SUPPURATION

I have seen two cases of edema of the conjunctiva resulting from the pressure of a sand-bag during an operation; one was accompanied by bilateral exophthalmos. Both patients suffered from thrombosis of the veins emptying into the jugular bulb from aural suppuration.

Diagnostic Importance of Induced Exophthalmos or Chemosis.—Consequently, if continued pressure from a sand-bag applied to the neck causes ocular edema, it is presumptive evidence that the infection in a venous sinus within the domain of the ear has extended into the cavernous sinus; otherwise the return circulation from the eye could not be disturbed. Chemosis and exophthalmos due to pressure may be regarded as an expansion of Crowe's sign. Consequently with symptoms of thrombophlebitis of a venous sinus around the ear, the appearance of chemosis or exophthalmos from the pressure of a sand-bag on the neck is diagnostic of involvement of the cavernous sinus.

CASE 13.—*Spontaneous hemorrhages in the opposite conjunctiva in a case of otitic thrombophlebitis, exophthalmos and chemosis from continued pressure on the neck; subsequent keratitis, possibly due to sympathetic involvement of the orbital apex and low intra-ocular pressure.*

History.—A young girl, H. D., had pneumonia eight weeks previously. On the eighth day of the present illness she had pain in the right ear, necessitating para-

22. Eagleton,[12] p. 98, case 20.

23. Colombo, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4860.

centesis and later mastoidectomy. This was followed by aural sepsis of five weeks' duration with an up-and-down temperature and irregular chills. She never had any headache.

At the time of my examination there were small punctate hemorrhages into the conjunctiva of the opposite eye, and although both pupils were small, the left (the contralateral) was smaller than the right.

Operation.—There was pus in the lateral sinus. No bleeding occurred from the region of the jugular bulb.

While the patient was on the operating table, as the result of pressure from a sand-bag there gradually developed bilateral exophthalmos, with chemosis on the side of the free jugular vein. All exophthalmos and chemosis rapidly disappeared on removal of the sand-bag.

Influence of the Intra-Ocular Tension and Keratitis from Venous Infection, Possibly with Involvement of the Ciliary Ganglion.—Later, it was found that the intra-ocular tension of both eyes was reduced and keratitis appeared; the latter might have resulted from involvement of the ciliary ganglion. Slight indistinctness of the opposite fundus and paralysis of the opposite external rectus muscle accompanied the terminal basilar meningitis.

Comment.—Hemorrhages into the left conjunctiva in this case may have been due to emboli from the heart, as there was albumin in the urine.

CASE 14.—A young man, R. W.,[24] had pyemia from an ascending septic thrombophlebitis originating from a septic sore throat with cervical adenitis. A purulent venous clot invaded the internal jugular vein and retrograded into the jugular bulb, the lateral sinus and the petrosal sinuses, finally reaching the cavernous sinus.

During the whole course of the disease the only symptom of venous obstruction of the ocular region was chemosis of the conjunctiva from the pressure of a sand-bag while the patient lay on the operating table at the time of the evacuation of a suppurating clot from the lateral sinus.

DIFFERENTIAL DIAGNOSIS BETWEEN INFECTION OF THE RETROBULBAR SPACE AND THE USUAL PHLEBITIC ORBITAL PHLEGMON

The vision of an eye with exophthalmos should be systematically tested at least once daily, as the patient is generally not aware that the sight has diminished, because the swelling of the lids engages all of his attention. Usually the loss of vision is appreciated only when the edematous lids are forcibly opened, although one of my patients (case 5) suddenly announced, "I cannot see," which he discovered because there was but little swelling of the lid.

TREATMENT OF THE RETROBULBAR SPACE INFECTIONS; EARLY ORBITAL DECOMPRESSION AND INCISION INDICATED FOR THE PREVENTION OF CAVERNOUS SINUS THROMBOPHLEBITIS

As (1) I have pathologically demonstrated (case 2) that (*a*) the obliteration of the arteries and (*b*) the steaminess of the cornea, which occur suddenly in cavernous sinus phlebitis, are due not to emboli but

24. Eagleton,[12] p. 66, case 17.

to a septic inflammation affecting the arterial system within the fascial muscular retrobulbar cone of the apex; and since (2) orbital decompression relieves exophthalmos, as demonstrated by the partial removal of the bony exostosis of the outer and upper orbital walls, I would lay down the dictum that in all phlebitic diseases of the orbit, orbital decompression should be performed immediately on the first appearance of (*a*) whiteness of the disk or (*b*) haziness of the cornea, no matter how slight the exophthalmos may be. The orbital decompression should be accompanied by an incision through the musculomembranous layer of the retrobulbar tissue, which allows inspection of the infected tissue as well as drainage.

The relief of a localized orbital phlegmon within the cone should suffice to control the infection in a considerable number of cases and thus prevent its extension into the cavernous sinus.

TECHNIC OF THE LATERO-ORBITOCRANIAL APPROACH TO THE RETROBULBAR SPACE [25]

The solid bony angle of the temporofrontal region and of the lacrimal fossa of the orbit is removed; thus both the outer and the superior area of the orbit may be entered through the lacrimal fossa and the anterior fossa of the skull. The orbitocranial opening is extended posteromesially, toward the optic foramen, passing over the roof of the orbit parallel with the orbital plate of the lesser wing of the sphenoid bone. The extensive removal of bone is followed by elevation and separation of the dura from the floor of the anterior fossa.

An incision through the intramuscular membrane now allows exposure of the retrobulbar contents of the orbit. By this method alone can a proper inspection of the retrobulbar fasciomuscular cone be obtained and the space effectively drained without sacrificing the eye.

OPERATIVE TREATMENT OF PURULENT THROMBOPHLEBITIS OF THE CAVERNOUS SINUS

Cavernous sinus thrombosis from (*a*) a phlebitic orbital phlegmon or (*b*) aural suppuration is a true venous sinus thrombophlebitis, i. e., an abscess in the midst of a protecting thrombus.

The surgical procedure indicated, as in all cases of venous sinus abscess, is drainage, although even with pus in the cavernous sinus the reactive elements within the vessel may first localize the infection by the formation of a clot both above and below the area of infection, and later may phagocytose the causative bacteria. Thus, a low grade compensatory septic process may be cured spontaneously (case 9).

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25. Eagleton, Wells P.: A Case Showing the Possibility of Exploring the Orbital Contents from Behind Through the Cranial Fossa, Arch. Ophth. **41**:162, 1912.

Evacuation of a septic clot and drainage of the cavernous sinus can be accomplished by (1) evisceration of the orbit and (2) removal of the outer edge of the superior orbital fissure which exposes the cleft between the cavernous sinus and the dura of the middle fossa.[26] The cavernous sinus is easily located by passing a probe through either the superior or the inferior ophthalmic vein into the sinus. The probe is continued in the sinus until stopped by the petrous apex. Incision of the vein and cavernous sinus on the probe allows the insertion of a drain into the sinus.[27]

Ligation of the Carotid Artery Prior to an Operation in the Cavernous Sinus.—In all cases of cavernous sinus thrombosis the common

Fig. 7.—Photograph of the brain showing the influence of ligation of the carotid artery in the control of venous stasis (left side of the illustration).

carotid artery should be ligated primarily, but always under local anesthesia, for if the ligation disturbs the circulation of the retina or causes cerebral anemia, the ligation must be but fractional.[28]

Restoration of Vision Following Ligation of the Carotid Artery.—Ligation of the carotid artery in itself not only (*a*) places an inflamed cavernous sinus at rest but it (*b*) relieves the venous stasis (fig. 7)

26. Mosher, H. P.: The Orbital Approach to the Cavernous Sinus, Laryngoscope **24**:709, 1924.

27. Eagleton,[12] p. 136, case 22.

28. Eagleton, Wells P.: Localizing Value of the Ophthalmic Examination in Suppurative Disease of the Brain, J. A. M. A. **92**:715 (March 2), 1929, case 5.

which always accompanies infection,[29] as I have witnessed (1) chemosis and exophthalmos markedly subside immediately after ligation (case 6).

In addition, it certainly has (2) a marked influence on the ocular circulation, as in one case an eye which was totally blind had useful vision (case 6) on the morning following ligation.

Protection of the Eye After all Operations for Septic Lesions of the Orbit.—All orbital operations, especially for septic lesions, should be completed by: (1) sewing the lids together and (2) covering the eyelids with a large sheet of rubber tissue greased with petrolatum. This should invariably be done after any operation for nasal sinus suppuration in which the septum orbitale is injured, as I have been called to see three patients in whom the sight of an eye had been completely lost by exophthalmos following an operation on the frontal sinus; the proptosis developed under the bandage, the pressure of which with its dryness caused the cornea to ulcerate.

PULSATING EXOPHTHALMOS DUE TO ARTERIOVENOUS COMMUNICATIONS WITHIN THE CRANIUM

Frequency of Pulsating Exophthalmos of Intracranial Origin.—Frost,[30] in nineteen autopsies in cases of pulsating exophthalmos, found:

Condition	Cases
Arteriovenous communication	8
Diseases of the cavernous sinus	2
Aneurysm of the orbital portion of the ophthalmic artery	2
Orbital aneurysm	3
Total verified cases as to cause	15
Undetermined	4
Total	19

That is, ten of fifteen, or 66 per cent of all cases of pulsating exophthalmos were due to some type of intracranial venous disturbance (Rivington [30a]).

Cause and Symptoms.—The pulsating is caused by the distended veins carrying arterial blood (Sattler [31]). The eye is apt to resemble an orbital phlegmon (fig. 8). The bruit may be heard only while the

29. Eagleton, in discussion on Vail.[19]

30. Frost, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4861.

30a. Rivington, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4861.

31. Sattler, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4861.

communication between the artery and the sinus is small. When the tear widens, which may happen at any time, the bruit is apt to disappear.[32]

Auscultatory Sounds Over the Orbit.—The normal auscultatory sounds heard over the head or orbit have never been adequately described. To my ear, they are made up of two elements: 1. Sounds from muscular contractions. These are uneven in degree and irregularly present but are always to be heard several times during the examination. (2) Vascular sounds. These suggest to me (*a*) the confused noises of a

Fig. 8.—Traumatic arteriovenous communication resembling an orbital phlegmon.

number of operating machines as heard on entering a factory, augmented by (*b*) a rhythmic pulsating, like the throb of a large engine operating in the midst of the many irregular revolving machines. This peculiar "rhythmic throb" is synchronous with the heart beat. Pressure over the homolateral carotid artery will often elicit it, when it is otherwise not audible, as is the rule in cases of arteriosclerosis (case 17).

I have frequently heard this rhythmic throb over the site of a cerebral tumor, which speaks for a highly vascular nature of the growth (case 17). The bruit of arteriovenous communications is a blowing noise substituted for this pulsating sound.

32. Eagleton, [12] p. 130, case 4.

SURGICAL TREATMENT OF PULSATING EXOPHTHALMOS

In pulsating exophthalmos the surgical procedure must be dictated by the position of the lesion. If there is an arteriovenous aneurysm from a tear in the internal carotid artery in its course through the cavernous sinus, to attempt its cure by a distal ligation of the superior ophthalmic artery is to invite disaster.

The flow of arterial blood into an intracranial arteriovenous aneurysm may be stopped by ligation of the carotid artery, but it may be necessary to ligate the opposite carotid artery after a long interval.[33]

If, however, the exophthalmos is due to dilated veins in the orbit itself, a Krönlein operation, or better still the frontocerebral route, will allow the application of Cushing's silver clip to the dilated vessel.[34]

After treatment, reduction of the brawny chemosis that remains for a long time following a protracted exophthalmos can be facilitated by systematic massage applied to the protruding conjunctiva, a rubber glove covered with petrolatum being used.

Differential Diagnosis of Arterial Aneurysm from Orbital Aneurysm.—Horton [35] has demonstrated that it is possible to differentiate an intracranial arteriovenous communication from an orbital aneurysm by the fact that the blood from the jugular vein on the side of the arteriovenous communication is of a darker color, and has greater oxygen capacity (Van Slyke gasometric method) than the blood from the opposite jugular vein, while in the orbital aneurysm the blood from both jugular veins is the same.

EXOPHTHALMOS FROM FRACTURES THROUGH THE OPTIC FORAMEN

In traumatic lesions, if exophthalmos is present it is due to the fracture passing through the annulus of Zinn, as hemorrhage into the orbit alone cannot cause it. If, however, the attachment of the external ocular muscles is injured, then hemorrhage may force the eye outward.

TUMORS OF THE ORBITAL WALLS: THEIR OSTEOGENESIS

The kind of primary tumor that may affect the orbital wall is dependent on the generic origin of the bone.

1. The outer orbital wall develops from cartilage, the resulting bone becoming filled with red marrow. For this reason it can be the seat of (*a*) a simple hyperplasia—"a true bone callus" (case 15)—as the

33. Eagleton,[12] p. 131, case 1.

34. Eagleton, [12] p. 76, case E.

35. Horton, B. T.: Intracranial Arterio-Venous Fistula: Diagnosis by Discovery of Arterial Blood in Jugular Veins, Proc. Staff Meet., Mayo Clin. **5**:178 (June 25) 1930.

marrow bone proliferates easily, or (*b*) it may be the seat of an osteochondromatosis of any grade from benignity (case 17) to the most active form of osteoblastic osteogenic sarcoma.[36]

2. On the other hand, the inner wall of the orbit is a "special sense-protective pneumatic" bone (Eagleton). At birth the bone spaces of the nasal capsule are filled with infantile fat marrow. During pneumatization the fat is absorbed and the pneumatized bone growth results in the formation of lamellar plates of compact tissue without bone marrow. Thus, in the bone of the inner orbital wall which covers a nasal sinus, stimulation through chronic irritation from infection produces a type of circumscribed ivory exostosis. The exostosis is apt to be (*a*) round when it occurs in the frontal sinus or (*b*) lobulated and pedunculated when it develops within an ethmoid cavity (case 16).

3. The roof of the orbit is made up of another type of special (visual) sense compact tissue bone. As far as I am aware, there is no record of the occurrence of a primary bone growth from the orbital roof.

Diffuse Bony Callus or Noncircumscribed Osteomas of the External Wall of the Orbit.—In my experience, a diffuse osteoma, i. e., a diffuse bony callus, is apt to develop in the outer wall of the orbit following slight trauma with a linear fracture of the bone (case 15); this occurs because the irritation of trauma causes the red bone marrow which fills the bone of the temporal fossa, including the outer orbital wall, to proliferate rapidly, forming bone callus, that is, vascular periosteal and endosteal bone.

CASE 15.—*Exophthalmos from diffuse callus formation of the outer wall relieved by orbital decompression.*

History.—A middle-aged woman, Mrs. S., had a goiter some years previously. On June 28, 1925, she suffered an indirect injury to her head, as a result of which she became unconscious for a few seconds. From the time of the accident, she complained of headache on the left side of her head and inability to concentrate.

Examination (March 19, 1926).—There was a localized swelling in the left temporal bone, just external to the angular process. It was slightly tender to pressure and was covered by enlarged veins. Marked exophthalmos of the left eye was present, which projected upward as well as outward.

Roentgen films revealed an area of density in the frontoparietal region, situated behind and above the orbit (fig. 9).

Operation.—The orbital wall and the bone of the adjacent part of the skull were from ¾ to 1 inch (1.9 to 2.5 cm.) in thickness. Puncture of the dura allowed the escape of a large quantity of fluid where the growing bone was irritating the arachnoid.

Postoperative Diagnosis.—The condition was a "bone callus from trauma associated with an aseptic meningitis, the reaction of irritation from growing bone."

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36. Geschickter, C. F., and Copeland, M. M.: Tumors of Bone, New York, American Journal of Cancer, 1931, p. 2.

Course.—The operation was followed by relief of the exophthalmos and of all headache, although the roentgenograms still showed considerable thickening of the orbital region (fig. 10).

December 1933 (eight years later): The patient has continued well.

Ivory Exostosis of the Nasal Sinuses as the Cause of Exophthalmos.—On the other hand, the inner wall formed by the bone of the nasal accessory sinus is composed of respirato-olfactory sense compact bone, and when it is irritated by infection, augmented by other unknown fac-

Fig. 9 (case 15).—Roentgenogram taken before operation showing bony callus of the outer orbital wall causing exophthalmos.

tors, it may produce a new growth—a type of growth similar to normal compact bone of this region, i. e., a compact tissue exostosis.

Two Types of Osteoma.—There are two types of osteoma which cause exophthalmos, viz: (1) the circumscribed round osteoma of the frontal sinus and (2) the pedunculated ethmo-orbital exostosis. Both spring from a nasal sinus; the former arises from the frontal sinus and is apt to extend early into the cranial cavity, while the latter first invades the orbit.

Infections[37] *as the Cause of Exostosis within the Accessory Nasal Sinuses.*—My experience has been that exostoses are always accompanied by an infection of the mucous membrane of the sinus from which the growth springs, for in all my cases, even when free pus was not seen at operation—and it usually was present—a culture from the thickened mucous membrane revealed micro-organisms. Consequently, I am of the opinion that an ivory exostosis of the nasal sinuses is the result of a chronic bacterial irritation applied to an area of osteogenic bone

Fig. 10 (case 15).—A roentgenogram of the same patient after operation. Figures 9 and 10 show that an orbital decompression with the removal of comparatively little of the bony contraction of the orbit will entirely relieve the exophthalmos. This allows room for the lateral expansion, thus freeing, as it were, the retrobulbar space.

37. Cushing is of the opinion that the ethmo-orbital exostoses are due to an unsuspected fracture at the junction of the orbital plate with the ethmoid capsule, stimulating into activity a cartilaginous anlage of bone growth (Kolodny, A.: Cranial Changes Associated with Meningioma Dural Endothelioma, Surg., Gynec. & Obst. **48**:231, 1929).

still capable of growing. Such areas occur where, during embryogenesis, the cartilaginous bone of the nasal capsule is covered by an "investing" membranous bone from the face, the resulting bone being "appositional" or membranous bone, which is of the compact tissue variety. It is in the cleft between the cartilaginous and the membranous bone that pneumatization occurs. Such areas at birth contain fat marrow; they grow actively during the first two decades of life. Thus, under the stimulation of infection within a sinus an ivory exostosis may develop, taking its lobulated shape from the ethmoid cells.

A pedunculated osteoma of the ethmoid is apt to extend early into the orbit, causing marked exophthalmos long before it invades the cranial cavity.

As the growth increases, the part protruding beyond the sinus from which it springs is surrounded by a "collar" of normal nasal sinus compact tissue bone.

Surgical Removal of the Collar.—The surgical removal of an osteoma or exostosis of a nasal sinus is easily accomplished if the wedge-shaped "collar" of normal bone is removed by a powerful electrically driven briser. As soon as the outer border of growth is free, the entire growth can be "rocked" out of its bed with ease.

CASE 16.—*Pedunculated ethmo-orbital exostosis.*

A young woman, C., two years ago, following a "cold in her head," noticed that the right eye began to bulge without pain or diminution in vision. At the time of examination the patient was not conscious of double vision excepting occasionally. The red glass test, however, revealed homonymous diplopia in all sections of the field.

The right eye was proptosed and was 8 mm. lower than the left eye. A firm mass could be felt at the inner and upper angles of the orbit.

The eyes of the patient's sister had a "tendency to bulge." Roentgen plates showed "a lobular bony growth, which apparently filled most of the right ethmoid region projecting into the orbit but not involving the frontal sinus" (figs. 11 and 12).

Operative removal of a pedunculated lobulated exostosis from the inner angle of the orbit was accomplished by drilling away the "collar" of normal bone through which the mass protruded into the orbit. As the sinus was approached the tumor was seen to be covered by mucous membrane that could easily be stripped off the growth and from which bacteria grew on culture.

Histologic examination (Dr. Lewis Brown) showed: "The tumor is composed of numerous areas of new bone growth containing cells of varying size. The periphery of these areas shows considerable osteoblastic activity in the form of large osteoblasts. The surrounding bone is quite dense, and the cells are few. Those which are present are rather small."

Abscess of the Pia-arachnoid as a Complication of Ivory Exostosis of the Accessory Sinus; Its Frequent Recurrence.—Abscess of the subdural space in the frontal lobe or of the pia-arachnoid is apt to be a complication of an ivory exostosis, and although the removal of a nasal

sinus osteoma or exostosis is never followed by a recurrence of the growth and it never metastasizes, the intradural suppuration which accompanies it may recur several times. I have had one case in which the intradural suppuration reappeared eight years after the removal of the bony tumor and again seventeen years after the original operation.

MENINGOBLASTOMAS ABOVE THE ORBITAL ROOF AS THE CAUSE OF EXOPHTHALMOS

The two varieties of growth of the roof of the orbit that are of surgical importance are (1) meningoblastoma (Mallory), Cushing's

Fig. 11 (case 16).—Roentgenogram showing pedunculated orbito-ethmoid exostosis projecting into the orbit.

meningioma of the sphenoid ridge,[38] which causes decalcification[39] of the bone but rarely invades the orbit at an early stage; and (2) the meningoblastoma of the olfactory groove. In former days tumors of the olfactory groove were allowed to attain enormous size before being operated on, when they frequently caused bilateral exophthalmos.

38. Bailey, Percival: Intracranial Tumors, Springfield, Ill., Charles C. Thomas, Publisher, 1933, p. 176.

39. Camp, J. D.: Intracranial Calcification and Its Roentgenologic Significance, Am. J. Roentgenol. **23**:615, 1930.

Osteogenic Character of the Special Sense Bones[40] *of the Sphenoid Ridge and Olfactory Groove Not Favorable to the Growth of an Overlying Cranial Exostosis of the Orbital Roof; Exophthalmos, if Present, the Result of Invasion of the Orbit by the Tumor.*—It is to be noted that in meningoblastoma of the olfactory groove exophthalmos does not occur until very late, when the after-growth has invaded the orbit; this is because an overlying cranial exostosis, which is so frequently present with meningioma of other parts of the cranium, does not occur in the orbital roof.

Fig. 12 (case 16).—Lateral view of the same patient showing the growth filling the entire ethmoid region and projecting slightly into the frontal sinus.

I am of the opinion that this absence of exostosis over a meningoblastoma of the olfactory groove or of the inner part of the sphenoid ridge is due chiefly to the special sense nature of the bones of this region.

40. Eagleton, Wells P.: Infections of a Petrous Apex and of the Spheno-Occipital Basis as a Cause of Suppurative Meningitis: A Study of Bone Growth in Its Relation to Pyogenic Lesions, with Especial Reference to the Influence on Infections of the Hematopoietic Producing Reticulo-(Histocytic) Endothelial Elements that Are Contained Within the Marrow of Bone, to be published.

Kolodny [41] believed that the bony proliferation of an overlying exostosis is evidence of a defense reaction of the bone, because of the increase of its blood vessels.

Both the special sense ophthalmic portion of the sphenoid ridge and the special sense respirato-olfactory bone of the olfactory groove are almost avascular from birth, and consequently do not readily respond by proliferation, as does bone marrow-containing bone, although continued pressure in either location at first causes decalcification and then absorption. Exostosis superimposed on a meningioma is always accompanied by an infiltration of the bone itself (Penfield [42]).

On the other hand, a meningoblastoma which is situated well outward on the sphenoid ridge may stimulate the medullary tissue around the pterion and produce diffuse thickening of the bone near the apex of the orbit; however, it but rarely occasions exophthalmos.[43]

CONGENITAL ANOMALIES AND DEHISCENCES OF THE ORBITAL ROOF AS A CAUSE OF EXOPHTHALMOS

(*a*) Developmental anomalies in the orbital roof, such as are present in tower skull, may give rise to marked exophthalmos, or the roof may be the seat of (*b*) congenital openings through which cranial tissues (meningoceles or encephaloceles) may project, or (*c*) openings from metabolic disturbances from lipoid dystrophy, such as those in Schüller-Christian's disease, may develop, any of which may occasion exophthalmos.

OTHER CAUSES OF EXOPHTHALMOS

Thyrotoxicosis and Hypertension as Predisposing Causes of Exophthalmos.—Thyrotoxicosis or hypertension may predispose to exophthalmos. Thus, of the cases herein reported, in one (case 11) there was an enlarged thyroid several years before the cavernous sinus infection, and in two others (cases 15 and 17) hypertension was present some years before the tumor formation.

Influence of Trauma in the Production of Bony Tumors of the Orbital Walls.—Traumatism certainly plays a large rôle in the develop-

41. Kolodny, A.: Cranial Changes Associated with Meningioma "Dura Endothelioma," Surg., Gynec. & Obst. **48**:231, 1929.

42. Penfield, Wilder: Cytology and Cellular Pathology of the Nervous System, New York, Paul B. Hoeber, Inc., 1932.

43. David and Stuhl established a quasi-certain diagnosis of meningoblastoma of the lesser wing of the sphenoid bone in three of twenty-three cases and in five other cases a probable diagnosis of such a tumor. Reliable signs indicating osteoma of the lesser wing of the sphenoid bone are localized atrophy and calcification. David, M., and Stuhl, L.: Roentgenologic Signs in Meningioma of Lesser Wing of Sphenoid, J. de radiol. et d'électrol. **17**:193 (April) 1933.

ment of bony growths of the outer walls of the orbit (case 17), but not of the bony tumors of the inner nasal surface, which, as previously stated, result from infection.

Angio-Endotheliomas Involving the Orbital Walls, Associated With Disseminated Areas of Calcification Within the Skull.—In one of my cases of angio-endothelioma (case 17) the bone surrounding the orbit thickened. The calcification was so diffuse that ultimately isolated areas appeared in the falx cerebri.

CASE 17.—*History.*—A young man, C. B., in 1927 fell on the ice and struck his nose. A year later he first noticed a slight swelling of the upper lid, which

Fig. 13 (case 17).—Exophthalmos before operation.

gradually increased. On March 23, 1929, he had slight exophthalmos, the left eye being a little lower and more prominent than the other.

Examination.—There was no annoying diplopia, but with the red glass test there was double vision in the upper field. The veins of the left fundus were fuller than those of the right side. On auscultation over the eye no abnormality was heard, but pressure on the carotid artery produced alteration of the normal sounds. The thyroid was slightly full, and there was a fine tremor of the fingers.

The basal metabolism was normal. Roentgenograms at this time were negative.

Diagnosis.—The condition was considered tumor of the optic nerve.

Course.—In April 1931 (two years later) the exophthalmos had increased markedly. There was slight ptosis (fig. 13) and a mass about the size of a peanut could now be felt in the upper temporal angle of the orbit.

Auscultation over either eye revealed a bubbling noise, which was louder on the left side.

Pressure on the carotid artery had no effect on the noise or the proptosis.

Roentgenographic Examination.—There was sufficient pathologic change of the bone to account for exophthalmos within the left orbit. Dr. Charles F. Baker reported: "It is my impression that at the time of the injury there was a fracture which involved the posterior and outer portions of the left orbit, for there is a dense white line 3 cm. in length, extending well into the orbit and terminating in the middle third of the sphenoid fissure. It is very opaque, and I believe that it indicates callous formation. However, it may be due to thickening of the periosteum and not to deposits of new bone. Extending along the greater wing

Fig. 14 (case 17).—Roentgenogram showing the general bony thickening of the orbit in a case of angio-osteomyoma.

of the sphenoid bone there are also shadows of increased density, rectangular in outline, which also suggest bone thickening" (fig. 14).

Operation.—A Krönlein flap of the left orbit exposed many nodular masses attached to the outer orbital wall. They were easily peeled out of the orbital bed, with little bleeding.

Histologic Examination (Dr. Lewis Brown).—"The tumor is composed of firm blood capillaries and fibrous tissue. The fibrous tissue is of the adult type. The blood vessels are numerous, with only slight activity of their lining cells. There is no evidence of malignancy."

Diagnosis.—The condition was diagnosed as angiofibroma of the orbit.

Postoperative Result.—Immediately following the operation the eye resumed an almost normal position (fig. 15); although the veins of both fundi continued to be large, and the left disk was slightly pale.

After several months of freedom from all symptoms there was a very gradual return of the exophthalmos and two and a half years after the operation the patient was again unable to close the lid over the eye.

Second Operation.—The bone of the outer wall of the orbit, which was infiltrated by a gelatinous material, was removed extensively. This allowed exploration of the orbit, which was now found to be filled with diffusely and firmly encapsulated tissue masses, the center of each mass being soft and easily enucleated.

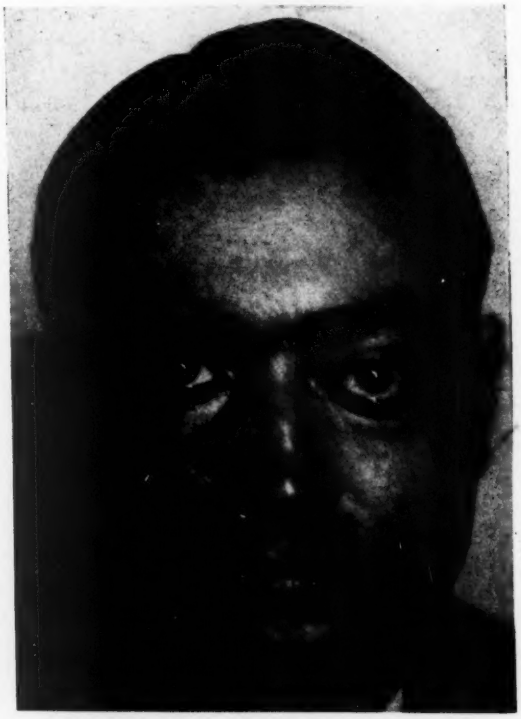

Fig. 15 (case 17).—Slight exophthalmos remaining after Krönlein operation.

Histologic Examination (Dr. Lewis Brown).—A section of the growth was composed of many small blood vessels, the walls of which showed marked endothelial proliferation. There were proliferating cells and in places masses in which no vessels could be distinguished. Histologically, the cells were only moderately active, but there was some evidence of the low grade malignant character of the tumor.

The diagnosis based on the microscopic picture was angio-endothelioma.

Subsequent Course.—The operation failed to relieve the exophthalmos; an ulceration of the cornea resulted from the swelling and operative trauma, following which the eye was enucleated. Radium treatment then caused a recession of the orbital tissue, so that the orbit is now carrying an artificial eye.

Comment.—In the light of my present knowledge I am of the opinion that the exophthalmos was not controlled and the eye was subsequently lost because of failure to decompress the posterior part of the orbit sufficiently. This should have been done on both its lateral and its cranial walls and, if necessary, on the inferior maxillary surfaces, for if I had relieved the exophthalmos by sufficient removal of bone, the tumor of the soft parts might have been controlled by irradiation and the eye saved.

Leontiasis Faciei.—Although I have seen a number of cases of leontiasis faciei, none of them has been associated with exophthalmos (Dreisch [44]).

Fig. 16 (case 17).—Roentgenogram taken after the second operation which consisted of extensive removal of bone. Note the calcification in the falx cerebri, which shows the diffuseness of the calcium reaction within the skull.

REMARKABLE POWERS OF COMPENSATION OF THE BINOCULAR FUSION MECHANISM; ORBITAL DECOMPRESSION FOR EXOPHTHALMOS PROMPTLY FOLLOWED BY RESTORATION OF SINGLE VISION

Bony growths of the sides of the orbit, congenital bony deformities, such as in tower skull, and inflammatory swellings from the inner

44. Dreisch, cited in Wood, Casey: American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 7, p. 4857.

nasal sinus or from the lower maxillary sinus press the orbital contents forward, causing proptosis, which has the effect of decompressing the orbit. It is the exophthalmos which prevents injury to the nervous and circulatory mechanism within the retrobulbar spaces that are necessary for the proper functioning of the eye. Spontaneous decompression by the development of exophthalmos is a protective measure, and so skilfully is the binocular compensation performed that when the exophthalmos appears gradually (as in cases 16 and 17) there is no accompanying double vision, except at intervals and in infrequent positions of the eyes.

Restoration of Binocular Vision by Paralysis of the Opposite Superior Oblique Muscle.—On one occasion, a frontal sinus operation resulted in diplopia from the destruction of the bone to which is attached the "pully" of the superior oblique muscle. Following a similar operation on the opposite frontal sinus two years later, the double vision immediately disappeared.

SUMMARY

1. The orbit is a bony goblet-shaped cone, open in front.

2. Posterior to the eyeball, the orbit contains a closed fasciomembranous muscular space, for which I would suggest the name "protective retrobulbar space."

3. This space is filled with fat in a semiliquid state. Histofunctionally, it is a visual sense-protective space, for it (*a*) contains ectodermal elements and mechanisms for the protection of the eye from circulatory disturbances from behind as well as (*b*) acts as a cushion against external trauma. It (*c*) reacts uniquely to infection.

4. The arterial blood supply within the retrobulbar space is of cerebral origin. The arteries spring from the junction of the vascular bed of the arachnoid base within its dural covering.

On the other hand, the venous return is diversified, the blood passing chiefly through the cavernous sinus, anteriorly escaping by way of the facial system, and inferiorly into the nasopharynx and the infratemporal fossa. Thus, a physiologic increase in the amount of blood within the space is promptly compensated for without displacement of the eyeball, provided the veins and arteries possess their normal reactive contractile properties. However, any increase in the total amount of arteriovenous blood retained within the space results in exophthalmos.

Thus, the extreme exophthalmos of exophthalmic goiter, which is out of proportion to the other symptoms of hyperthyroidism and in which autopsy fails to disclose sufficient pathologic change to account for the proptosis in the orbital contents, (*a*) is uniformly relieved by orbital

decompression (Naffziger [45]); this is because the exophthalmos (*b*) is due to an overfilling by blood of the retrobulbar space from distention of the veins.

5. Two thirds of all cases of pulsating exophthalmos are due to an increased amount of circulating blood within the retro-orbital space, the result of an intracranial arteriovenous communication.

6. Sudden phlebitic invasion of the retrobulbar space is characterized by (*a*) diminished or complete loss of vision, with (*b*) constriction of the arteries of the retina from *stupeur artérielle* (Leriche)—arterial coma. The fundus changes are apt to be associated with (*c*) haziness of the cornea out of proportion to the proptosis and with (*d*) pupillary abnormalities—smaller pupils (case 2).

7. The whitish nerve head and the absence of retinal arteries present a different ophthalmoscopic picture than that seen in embolism of the central artery of the retina, the usual cherry-red zone around the macula being absent.

8. The blindness, with contracted arteries, is a protective reaction, due to the sudden effect of the infection on the sympathetic nervous mechanism within the retrobulbar space. A somewhat similar ophthalmoscopic picture, but without diminution of vision, is frequently seen immediately following severe cranial trauma. This, however, is probably the result of a disturbance of the central sympathetic mechanism within the brain.

9. The exophthalmos, chemosis, swelling of the eyelids and ocular fixation in cavernous sinus thrombophlebitis following an infection of (*a*) the face, (*b*) the lip or (*c*) the nasal orifice as a rule are the result of a diffuse thrombophlebitic phlegmon of the orbital tissues. In this type of cavernous sinus infection, the fundus changes are limited to (*a*) distention of the retinal vessels, and there is (*b*) no reduction of vision until haziness of the cornea appears.

10. "Blue eyelids," slight and transient proptosis, with or without chemosis, in the presence of a suppurating ear and a compensatory thrombophlebitis within an adjacent venous radicle are suggestive that the infection has involved the cavernous sinus. The orbital symptoms are due to a transient venous stasis from interference with the return venous flow from the anterior part of the cranial cavity. In these cases, chemosis and exophthalmos can be reproduced by the continued pressure in the neck from a sand-bag during operation.

11. Consequently, in exophthalmos associated with or resulting from a suppurative lesion of the face, nasal cavity, or ear, the surgeon should

45. Naffziger, H. C.: Progressive Exophthalmos Following Thyroidectomy, Ann. Surg. **94**:582, 1931.

decide before exploration of the orbit which of the following types is present:

(*a*) Exophthalmos due to a localized orbital abscess following nasal sinus suppuration. Incision and drainage along the inner orbital wall promptly relieve the condition.

(*b*) Exophthalmos, the result of either a slowly or a rapidly advancing orbital phlegmon, the causative lesion of which is diffuse endophlebitis of the orbital veins following a carbuncular infection of the lip, nasal orifice or eyelid. In diffuse phlebitic phlegmon, blind operative trauma into the orbit in the hope of finding pus only accelerates the phlebitic infection. In the past such a procedure has too frequently converted a semiquiescent orbital phlegmon into a fulminating diffuse lesion with immediate cavernous sinus phlebitis.

(*c*) Slight or severe proptosis from infection of the protective retrobulbar space is diagnosable by (*a'*) sudden loss of vision, (*b'*) whiteness of the nerve head, (*c'*) contracted arteries, which may be associated with steaminess of the cornea out of proportion to, and, thus not accounted for by, the amount of proptosis and (*d'*) delayed and impartial dilatation of the pupil on the homolateral side. These symptoms call for the immediate opening and drainage not of the periorbital tissues but of the retro-ocular space itself.

12. Exploration and drainage of the retrobulbar space are best accomplished through a latero-orbitocranial approach.[46] If drainage is instituted early it may prevent necrosis of the retro-orbital fat and extension of the infective phlebitis into the cavernous sinus.

13. An operation for any phlebitic process that involves the cavernous sinus should be preceded by a complete or fractional ligation of the common or internal carotid artery, because the ligation (*a*) places the inflamed cavernous radicle at rest and (*b*) relieves venous stasis as well as (*c*) controls hemorrhage, which in cases of phlebitis is always so profuse as to prevent proper inspection of the parts and has resulted fatally in several instances.

14. Several cases are herein reported in which ligation of the carotid artery alone has relieved the exophthalmos and, in one instance, restored vision to the eye.

15. Slowly growing bony tumors of the orbit which exert pressure outside of the fasciomuscular cone cause but relatively slight displace-

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46. Eagleton, Wells P.: A Case Showing the Possibility of Exploration of the Orbital Contents from Behind through the Cranial Fossa, Arch. Ophth. **41**:162, 1912; Traumatic and Infective Lesions of the Head, the Chief Manifestations of Which Are Visual Disturbances, Their Diagnosis and Surgical Treatment, S. Clin. North America **6**:1435 (Dec.) 1926.

ment of the eyeball. Orbital decompression, if it is performed over the site of the maximum pressure, completely relieves exophthalmos. Consequently, in bony tumors of the orbital wall complicated by exophthalmos the orbital decompression should aim at complete freeing of the retrobulbar space.

EXOPHTHALMOS

OCULAR COMPLICATIONS; CAUSES FROM PRIMARY LESIONS IN THE ORBIT; SURGICAL TREATMENT

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A symposium on a given subject is really analogous to taking stock. One attempts to determine the present status of the problem. When all has been said, one is sometimes reminded of the light in hell that Milton described as being just bright enough to make the darkness visible.

However, thinking in retrospect over the particular phases of exophthalmos with which I am concerned, I find quite a few encouraging signs of progress. They are manifested strikingly in regard to the histogenesis and histology, and thus the accurate terminology, of tumors. The older reports on orbital tumors are in many instances without much value because of loose, inaccurate terms which fail to classify the new growths properly in a manner that assures uniform understanding. Sarcomas are often reported as belonging to the small or the large round cell type, although now such a diagnosis is considered insufficient. An attempt is made to state the genesis of the tumor by using a designation that indicates the type of cell, such as myosarcoma, neurosarcoma, osteosarcoma or lymphosarcoma. Formerly, the mixed tumors of the lacrimal gland were called endotheliomas, and were therefore confused with the primary and secondary meningiomas. Likewise, the varied manifestations of the meningiomas were given all kinds of names. The use of many different terms to designate tumors with a similar histogenesis has thus led to confusion and has retarded progress in the knowledge of the various groups. With the more accurate classification of these tumors, it is now possible to state with more certainty, in regard to the various groups, their usual clinical course, their clinical peculiarities, their prognosis, their sensitiveness to radiation and their usual reaction to surgical procedures.

This paper deals mainly with primary tumors of the orbit and with the surgical measures employed in cases of exophthalmos. Before considering these topics, certain complications suffered by the eyeball will

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be considered. One of the most frequent complications of the eye resulting from exophthalmos is an ulcer due to corneal exposure. In testing whether or not the lids protect the cornea properly, it is important to have the patient passively close the lids as in sleep and not actively squeeze them together. The earliest manifestations of corneal exposure are irritation of the eye and punctate areas over the lower one third of the cornea which stain with fluorescein. If unheeded, these areas are the forerunner of an ulcer which, if unarrested, can progress to perforation and the loss of the eye. The presence of pressure or of inflammation around the optic nerve frequently causes papilledema and, in due time, atrophy. The same factors may also cause thrombosis of the central retinal vein. A tumor in the orbit may push the scleral wall in as well as push the eyeball out. In the early stages, this indentation of the sclera may occur before the eye is proptosed, and in such a case the hyperopia acquired is significant. If the indentation of the sclera is localized, it may in some ways resemble a flat detachment of the retina.

Acquired tissue around the globe, whether neoplastic or inflammatory in origin, may produce glaucoma, presumably by embarrassing the vortex system of veins. An orbital tumor may not only indent the sclera but even cause glaucoma before producing exophthalmos.

The presence of an orbital tumor in the majority of cases causes some amblyopia and not infrequently amaurosis. Most observers have attributed it to pressure of the tumor on the optic nerve. This does not seem to be the only factor, for the optic nerve may be completely embedded in a meningioma and the eye still have normal vision and fields. On the other hand, such soft, pliable tumors as hemangiomas [1] cause amblyopia or amaurosis in three fourths of the cases, and some of these tumors are not located in the muscle funnel or near the optic nerve.

Stretching of the optic nerve occasioned by exophthalmos does not seem to be an important factor. Sometimes the vision is markedly reduced with only from 3 to 4 mm. of proptosis, and, on the other hand, an enormous protrusion may cause little amblyopia. For example, in one instance the length of the optic nerve was estimated from roentgenograms to be more than twice its normal length, and still the patient had vision of 20/30 and normal fields. The optic nerve from the optic foramen to the globe has a course represented roughly by the letter S, and it is this slack which allows the free excursion of the eyeball and its protrusion without undue stretching.

1. Byers, W. G. M.: Arch. Ophth. **53**:280 (May) 1924. La Grange: Arch. d'opht. **33**:721, 1913. Schieck, F., and Brückner, A.: Kurzes Handbuch der Ophthalmologie, Berlin, Julius Springer, 1930, vol. 3, p. 79.

Hyperopia and hyperopic astigmatism caused by the tumor's pushing the sclera in form another cause of impaired vision. Owing to the irregularity of the astigmatism, it usually cannot be corrected with lenses. It seems probable that still another factor must exist to explain, satisfactorily the reduced vision in some instances. This must be a toxin emanating from the growth which causes dysfunction of the nerve.

Primary tumors of the orbit may be benign histologically but locally malignant in the sense that their slow growth may impair the function of the eye or reach the brain. To this group belong hemangiomas, gliomas of the optic nerve, meningiomas of the optic nerve sheath and mixed tumors of the lacrimal gland, all of which grow slowly over a period usually of years.

HEMANGIOMA

Hemangioma is the most common primary tumor of the orbit and is fortunately the most satisfactory with which to deal because it is usually encapsulated and is radium-sensitive. It is probably entirely congenital in origin, although it frequently grows so slowly that it gives no sign of its presence until the patient is in the first or second decade.

Two characteristics of some importance are the failure of these tumors to affect the motility of the eye and the variations in the size of the tumor, and thus in the extent of the exophthalmos. These variations may be spontaneous, due to a variable stasis in the venous circulation, or they may be produced by any maneuver which increases the congestion in the jugular area, such as compression of the vein, bending the head, crying or coughing. The same conditions produce exophthalmos in the condition known as varix orbitae or intermittent exophthalmos, and therefore some confusion may arise.

In the case of varix orbitae, exophthalmos is provoked only by the aforementioned conditions which congest the jugular area, and it disappears when the patient is in the ordinary standing, sitting or lying position. The condition usually manifests itself first about in middle age and is due to varicosities of the orbital veins which probably occur as a result of atresia of the foramen through which the jugular vein leaves the skull. It is apt to appear on the left side, for normally the foramen is smaller on this side.

MIXED TUMORS OF THE LACRIMAL GLAND [2]

The large majority of new growths of the lacrimal gland contain tumor tissue, some of which is ectodermal and some mesodermal in origin. These growths are therefore called mixed tumors and probably

2. Lane, L. A.: Am. J. Ophth. **5**:425 (June) 1922. Verhoeff, F. H.: J. M. Research **13**:319, 1905.

constitute fully 95 per cent of the neoplasms that arise from the lacrimal gland. Pure carcinoma of the gland is an extreme rarity. Sarcoma of the gland has never been reported.

These mixed tumors are congenital, although the average age at which they manifest themselves is 40 years. Van Duyse [3] reported a case in which, during the course of an operation for the removal of a portion of the lacrimal gland because of epiphora, he accidentally encountered a mixed tumor the size of a pea lying between the main gland and the accessory gland. This substantiates the belief that these tumors arise from isolated displaced and undifferentiated embryonic rests and not from the developed gland tissue. Because these mixed tumors have the potentialities of forming so many types of tissue, they naturally vary a great deal in their component structures. The term cylindroma has been employed to designate a certain manifestation of this tumor in which the epithelial element predominates in cylinder formation with a myxomatous stroma. The mixed tumors are not benign, as Lane reported in ninety-five cases in which there was 12.5 per cent mortality and 20 per cent recurrence. They are not just locally malignant, for 7 per cent showed distal metastasis. The growth becomes progressively malignant after each incomplete removal.

INTRANEURAL TUMORS [4]

According to Verhoeff, all primary intraneural tumors of the optic nerve are composed of neuroglia and therefore are correctly called gliomas. Clinically, a glioma of the optic nerve is extremely slow in growing and produces exophthalmos gradually in children in the first decade of life. Vision is usually affected before the onset of exophthalmos. Verhoeff discussed interestingly the mode of origin and growth of these tumors. Ordinarily, a tumor elsewhere evidently arises from a small focus, and as it grows it pushes aside and invades the surrounding tissue. In the case of glioma, whether it is in the optic nerve, in the brain or in the spinal cord, the growth increases in size by causing the preexisting neuroglia in the vicinity of the growth to proliferate. Sometimes this glial proliferation is seen as far forward as the disk and the contiguous portion of the retina, where in some instances it may reach considerable size and form a white, or even a cystic, mass. Also, glial proliferation accompanying a glioma of the nerve may be noted as far back as the hypophysis. Verhoeff's explanation of the proliferation of the neuroglia of the disk and the contiguous portion of the retina, and perhaps also of the hypophysis, is that some abnormal stimulating factor

3. Van Duyse: Arch. d'opht. **30**:401, 1910.

4. Byers, W. G. M.: Tumors of the Optic Nerve, J. A. M. A. **63**:20 (July 4) 1914. Verhoeff, F. H.: Arch. Ophth. **51**:120 (March); 239 (April) 1922.

is supplied in increasing abundance by or from the actively proliferating neuroglia of the tumor. This also explains the remarkable fact that there is not a single instance reported in the literature in which a recurrence of a glioma of the optic nerve has occurred, although in perhaps the majority of cases the removal had been incomplete.

EXTRANEURAL TUMORS [5]

The extraneural tumors of the optic nerve, or meningiomas, have the varied histologic picture of the same type of tumor arising from the meninges of the brain and the spinal cord.

They are particularly prone to produce changes in the contiguous bone, which changes, together with the fact that they affect adults, serve to distinguish them clinically from the intraneural tumors. They encapsulate, but the capsule tends to adhere to surrounding structures, which in the case of the extra-ocular muscles often causes injury when the tumor is removed without the globe.

SARCOMA

Sarcoma of the orbit may arise from a great variety of cell types—originate in connective tissue, muscle, nerve, periosteum, fat or lymphocytes. An analysis of fourteen cases from the Memorial Hospital, New York, showed that the twelve patients who could be traced lived, on an average, only one year after the first manifestation of the new growth. Regardless of the treatment, whether it was radiation, operation or both, a rapidly fatal course occurred. These figures are perhaps no more discouraging than those for sarcoma elsewhere in the body.

It is usually said that the younger the patient the more malignant the tumor. This was true of the cases at the Memorial Hospital in which the youngest patient was 15 months old and the tumor proved fatal in five months. The average age was 10 years.

PRIMARY CYSTS [6]

Of the primary orbital cysts, one of the most interesting types is the congenital coloboma cyst or retinocele. The cyst may enlarge after birth and produce marked exophthalmos. It always arises from the undersurface of the optic nerve at the site where the nerve enters the sclera, and it is due embryologically to a faulty closure of the fetal cleft, which allows a bulging or diverticulum of the retinal layer. The cysts are therefore lined with neuroglia or rudimentary retina. There is usually an associated microphthalmia, but occasionally the eye is of normal size and appearance. In such instances the question of whether

5. Bailey, P., and Bucy, P. C.: Am. J. Cancer **15**:15 (Jan.) 1931.

6. Calhoun, F. P.: Bilateral Coloboma of the Optic Nerve, Arch. Ophth. **3**:71 (Jan.) 1930.

or not a new growth is the cause of the exophthalmos may arise. The presence of an anomalous condition of the disk, iris, etc., is then important in making the correct diagnosis.

The dermoid cysts usually occupy the orbital margin in the region of the brow temporally, and less often nasally. Rarely they appear deeper in the orbit or extend from the usual superficial location back along the bony wall to the retrobulbar region. In extremely rare instances they may be in the shape of an hour-glass, with one side in the orbit and the other side in the temporal fossa. In such instances, pressing the jaws firmly together or pressure on the external portion of the cyst will force the contents into the internal portion and produce further protrusion of the globe.

Although these cysts are congenital, they may enlarge slowly or sometimes even grow so rapidly in the course of weeks or months as to produce pain.

PSEUDOTUMORS [7]

In some instances, it is impossible to tell from the clinical examination whether a real primary tumor or a pseudotumor exists in the orbit. That these two conditions can simulate each other in every detail is evidenced by the fact that in thirty cases of pseudotumor analyzed, exenteration of the orbit was performed in fifteen, or 50 per cent, for a supposed tumor, which proved by histologic examination to be an area of chronic inflammation instead. For some reason these cases of pseudotumor are seldom mentioned in the literature, maybe because one hesitates to broadcast one's mistakes. Nevertheless, pseudotumors of the orbit are fairly common, and it is often a difficult problem to differentiate them from real tumors. In the group of cases of pseudotumor analyzed, the following characteristics were found:

1. The average exophthalmos produced was 7 mm.

2. A mass which may be firm, well demarcated and discrete was palpable in the orbit in one half of the cases.

3. The vision was affected in two thirds of the cases and usually returned to normal after regression.

4. Complete regression, which often proceeds to enophthalmos and sinking of the tarso-orbital fascia, took place usually in from four to five months.

5. The condition was never recurrent.

6. Occasionally there was prodromal transitory edema of the lid and the conjunctiva some weeks or months preceding the appearance of the exophthalmos.

The most important points in differentiating a pseudotumor of the orbit from a real primary tumor are as follows:

1. Primary tumors of the orbit occur mostly in the first decade of life and rarely after the second decade. The average age for pseudotumors is 45 years.

7. Benedict, W. L., and Knight, M. S.: Arch. Ophth. **52**:582 (Nov.) 1923.

2. The onset of the exophthalmos in primary tumors is insidious and gradual. In pseudotumors the onset is relatively sudden, occurring in several weeks in most instances.

3. Primary tumors of the orbit are never bilateral. Pseudotumors affect both eyes in one third of the cases, but the second eye becomes involved from four to nine months after the first eye.

4. Primary, as well as secondary, tumors in the orbit not infrequently show roentgen changes of the orbital bones, whereas pseudotumors characteristically do not.

5. Primary tumors usually cause no pain and no swelling of the conjunctiva or the lids. Pseudotumors in one half of the cases give rise to some pain and some edema around the eye.

The microscopic examination of tissue in these cases shows chronic inflammation with certain distinguishing characteristics. There may be fibroblastic repair in all stages from the denser hyaloid, almost anuclear tissue of long standing to the delicate fibroglia and richly nuclear tissue of more recent production. Foci of lymphocytes are scattered through this repair tissue, and occasionally real lymph follicles with germinal centers are encountered. Blood vessels are plentiful; their intima often shows proliferation to such an extent that the lumen appears almost occluded, and their media and adventitia are thickened with sclerosis which has sometimes undergone hyaloid degeneration. When specimens are taken from this tissue for biopsy, there is often a tendency to bleeding, which in one instance necessitated packing and secondary closure. This tendency is explained by the vascular changes described.

The etiology of pseudotumor is not known. There is no evidence clinically or histologically that the lesion is tuberculous. Some observers claim that the lesion is a late manifestation of syphilis which has run its course; the Wassermann reaction is therefore negative. Of the group studied, only two patients had a positive Wasserman reaction of the blood and one had a positive reaction of the spinal fluid but a negative reaction of the blood. There are reports of regression of the exophthalmos under the usual treatment for late syphilis, but the effect may be absorptive rather than specific, and the condition, when untreated, subsides in a number of months. The histologic characteristics of the lesion and in particular the vascular changes described are not inconsistent with syphilis, but there is a preponderance of evidence which fails to substantiate a syphilitic etiology.

In connection with the pseudinoma, it may not be amiss to mention that a high degree of myopia may produce a prominence of the eye which, if unilateral, can be misleading. I know of one case in which there was 30 D. of myopia which was investigated from all angles in an effort to explain an exophthalmos of 4 mm. before the myopia was appreciated as the cause. Also, paralysis of one or more of the rectus

muscles or tenotomy of a rectus muscle may produce an exophthalmos of from 2 to 3 mm.

OPERATIONS

The operations indicated in cases of exophthalmos may be for cosmetic purposes, for the securing of more protection to the cornea, for excision of a tumor or for relief from pain.

Cosmetic Purposes.—The appearance of the patient can be materially improved by a shortening of the palpebral fissure at the external canthus, particularly in cases of exophthalmic goiter in which the protrusion of the eye is a definite blemish. A technic which will give the normal acute angle to the junction of the upper and lower lids at the

Fig. 1.—Wheeler's tarsorrhaphy. Over the desired distance of shortening, the conjunctiva and the skin including the cilia along the margin of the upper lid are excised. This leaves a denuded short tongue of tissue, including the tarsus. Over the same corresponding distance along the lower lid the cilia are excised, and a slit is made between the skin and the conjunctiva into which the denuded tongue of tissue from the upper lid is pulled and sutured with a double arm silk suture. The insert is a cross-section of the procedure.

external canthus and not a rounded obtuse angle is desirable. Such a technic, which I find satisfactory, is the one advocated by Wheeler (fig. 1).

In cases of hyperthyroidism in which the retraction of the upper lid rather than the protrusion of the eye constitutes the greater blemish, recession of the levator muscle as advocated by Goldstein [8] may be indi-

8. Goldstein, I.: Recession of the Levator Muscle for Lagophthalmos in Exophthalmic Goiter, Arch. Ophth. **11**:389 (March) 1934.

cated. In marked cases, when the exophthalmos and the retraction of the upper lid are both important factors, shortening of the fissure may be combined with the recession of the levator.

Protection to the Cornea.—If the lids fail to protect the cornea, particularly when passively closed during sleep, it may be necessary to resort to surgical measures to prevent the development of an ulcer or to prevent progression and promote healing of an ulcer already present. Surgical measures which tend to forestall the development of an ulcer due to corneal exposure are shortening of the fissure and recession of the levator muscle. However, if an ulcer is well established, it may be necessary to produce adhesions along the margins of the lid, thereby closing the palpebral fissure, in order to secure proper protection of the cornea. If adhesions between the margins of the lids are produced properly, they will usually remain indefinitely. The course of the ulcer can be watched and atropine instilled through the spaces intervening between the adhesions. At any time the adhesion can be severed, leaving no deformity to the margins of the lids. Merely suturing the lids together with mattress sutures is not sufficient, as these will hold usually not more than four or five days.

In cases of malignant progressive exophthalmos, sometimes seen in hyperthyroidism, Naffziger [9] advocated decompression of the orbit by resecting the orbital roof. As this is done from the anterior cranial fossa, it comes under the domain of the neurologic surgeon.

Removal of an Orbital Tumor.—Tumors that are located temporal to the muscle funnel, or in the muscle funnel, can be satisfactorily approached by a transconjunctival route in the following manner: A canthotomy is performed, and the fibers of the external canthal ligament, together with the tarso-orbital fascia are divided (fig. 2). The conjunctiva is incised along the fornix to the vertical meridian above and below the canthotomy. The conjunctiva is dissected free. If the tumor is in the muscle funnel, the external rectus muscle must be severed at its insertion (fig. 3). By retracting the globe nasally, good access to the orbit is obtained. I believe that any tumor can be removed as satisfactorily in this manner as by the Krönlein method and that the Krönlein operation is seldom, if ever, necessary. If one needs slightly more exposure than is afforded by the foregoing procedure, some of the margin of the bony orbit temporally can be removed with a rongeur without causing any cosmetic blemish. This additional procedure is rarely necessary.

The temporal transconjunctival approach gives sufficient access to the orbit for the removal of a tumor located anywhere but nasally. When a tumor occurs nasally in the orbit, neither this approach nor that

9. Naffziger, H. C.: Ann. Surg. **94**:582 (Oct.) 1931.

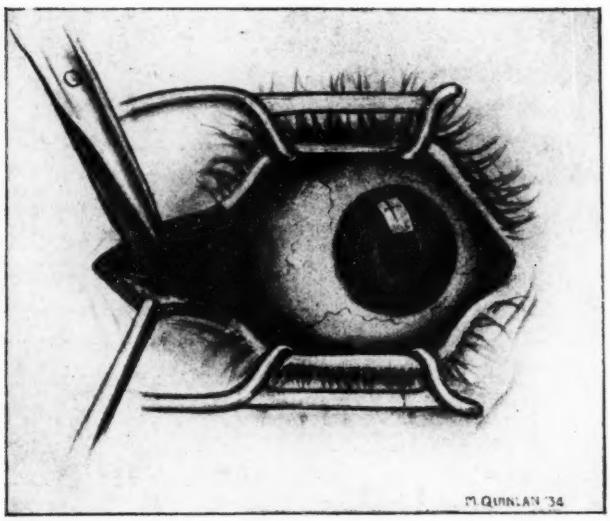

Fig. 2.—Transconjunctival approach to the orbit. A canthotomy has been done, and the external canthal ligament along with the tarso-orbital fascia is being incised.

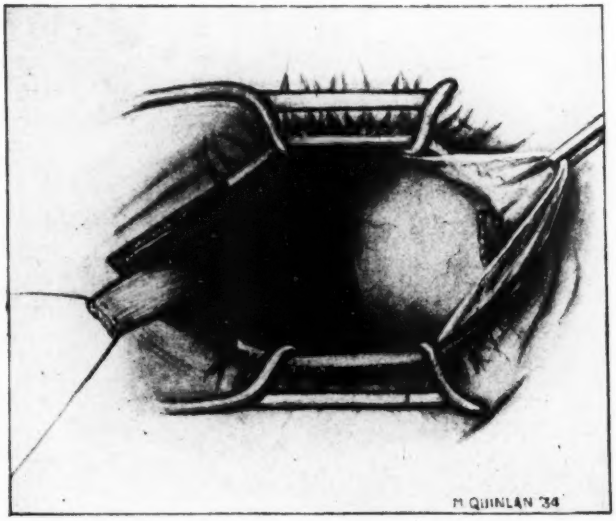

Fig. 3.—Transconjunctival approach to the orbit. The conjunctiva has been incised along the fornix to the vertical meridian above and below the canthotomy and dissected free. The external rectus tendon has been severed at its insertion and reflected. The globe is retracted nasally.

of Krönlein is satisfactory, because if the muscle funnel must be crossed in approaching the tumor, damage to the extra-ocular muscles, to the posterior ciliary vessels and nerves and to the optic nerve occurs to such an extent that it is not feasible to attempt to retain the globe. If the tumor is definitely in the nasal side of the orbit, the same trans-conjunctival approach can be utilized nasally. Even when a tumor lies in the muscle funnel, and particularly in the apex of the orbit, and can

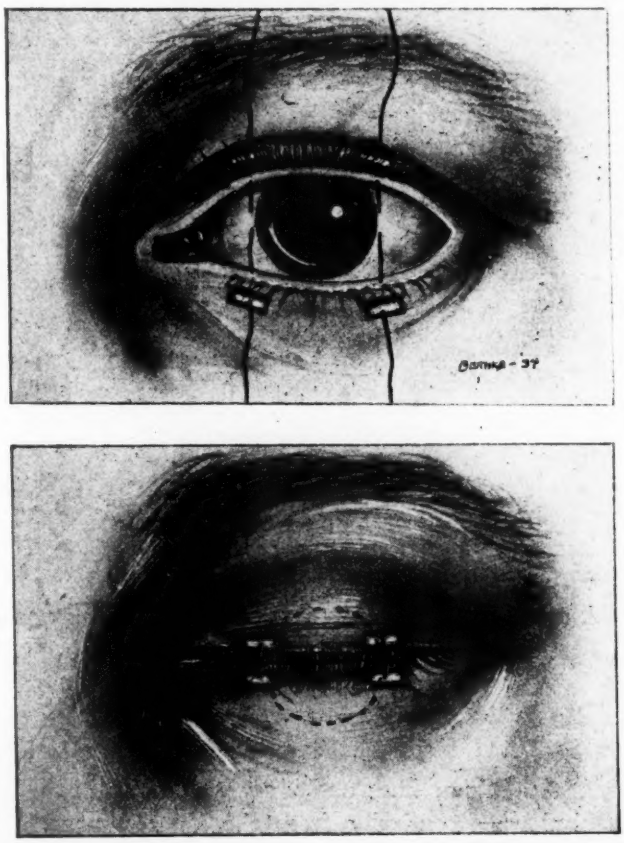

Fig. 4.—A procedure for holding the globe in the primary position and for preventing exophthalmos following the removal of an orbital tumor. The upper drawing shows the placement of sutures; the lower drawing, the sutures tied over rubber pegs.

be satisfactorily approached and removed, it sometines is so adherent to the extra-ocular muscles that the muscles must be damaged in removing it. When such damage to the extra-ocular muscles is extensive, exophthalmos, a poorly alined eye and ptosis will result. When one or several extra-ocular muscles are damaged, it is sometimes advisable to fix the eye in the primary position, so that the repair tissue formed

later in the orbit around the globe will fix it in good alinement and with no proptosis. This can be accomplished by passing a silk suture through the margins of the lids and through the episclera at the limbus nasally and temporally and tying it over the surface of the lids (fig. 4). A tenotomy of the opposing muscle may be advisable.

The fate of a globe left in situ when the optic nerve has been excised along with the orbital tumor is interesting. Immediately after excision of the nerve from the globe a view with the ophthalmoscope shows a slightly pale fundus, but the arteries, although somewhat narrower then normal, are filled with blood and the veins do not appear remarkable. In the course of some months, marked pigmentary changes occur over the fundus and even in the disk (fig. 5). Retinitis proliferans is sometimes noted. Iridocyclitis with secondary glaucoma may develop, and ultimately enucleation may be necessary. Verhoeff examined microscopically an eye the optic nerve of which had been severed several years previously. He found an extreme degree of atrophy of the choroid and retina with pigmentation of the latter by cells migrating from the proliferated pigment epithelium. As obstruction of the central vessels alone does not cause such changes, it is assumed that they occur as a result of the severing of the posterior ciliary vessels.

When the new growth is extensive or diffuse, or if it cannot or should not be locally extirpated, exenteration is indicated. In such cases, it is advisable to remove all but the skin of the lids. The skin of the upper lid is inverted on the roof of the orbit, and likewise the skin of the lower lid is utilized to cover the floor of the orbit. If the remainder of the orbit is allowed to granulate, discharge occurs over a long period, sometimes even for months, requiring frequent dressings. Therefore, if at the time of the exenteration a Thiersch graft is placed in the orbit, it will adhere readily and leave a clean nondischarging, odorless orbit one week after the operation. It is surprising how readily a graft adheres on bare bone supposedly deprived of periosteum.

Relief of Pain.—Sometimes patients with tumors in the orbit which have extended there secondarily from the sinuses, nasopharynx, etc., experience severe pain. Although the condition may be deemed inoperable and incurable, these patients can often be relieved from pain by exenteration.

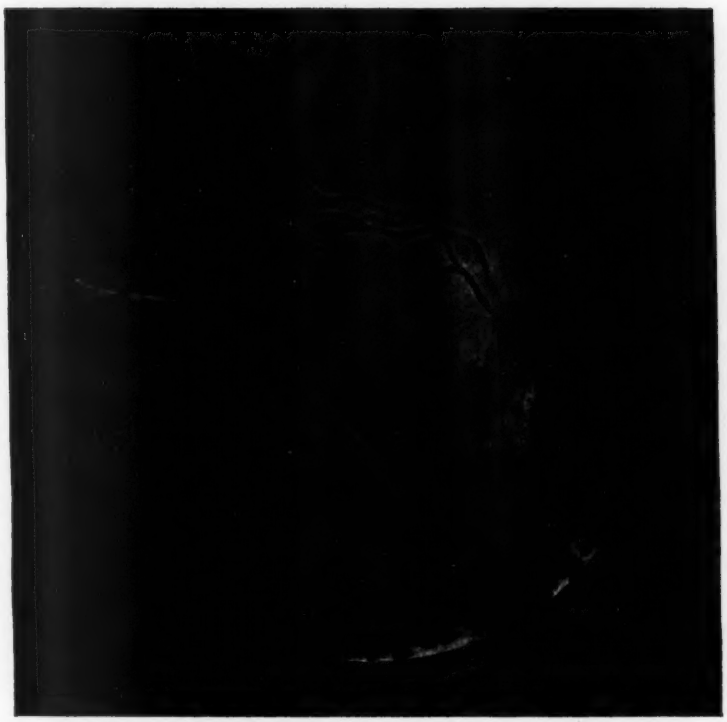

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Fig. 5.—The fundus after excision of an orbital tumor along with the optic nerve. A meningioma arising from the optic nerve sheaths was excised, leaving the globe in situ. Three months later this drawing of the fundus was made (patient of Dr. T. H. Johnson). There are diffuse changes in the pigment, particularly around and over the site of the disk. Also, in the region of the disk there are two sites of retinitis proliferans. The blood vessels in places appear as white lines. In the periphery below are white atrophic areas.

SUPRASELLAR ARACHNOID CYST

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REPORT OF A CASE

History and Preoperative Course.—S. H., a man aged 29, referred by Dr. Joseph Edeiken, was first seen on March 26, 1934. He complained of blurred vision and sharp retrobulbar pain which had been present for two weeks. The pain was especially marked on lateral movement of the eyes and on sneezing or coughing.

The ophthalmic examination showed that the pupils were regular and equal and responded promptly to all the tests for normal reflexes. The media were clear. The optic disks were normal in color and well outlined, and the eyegrounds appeared entirely healthy. Visual acuity was 10/200 in the right and 20/40 in the left eye. There was a bitemporal hemianopic paracentral scotoma extending above and below the horizontal line with a moderate bitemporal peripheral contraction (fig. 1). A provisional diagnosis of retrobulbar neuritis probably secondary to sinusitis, or of a pituitary lesion, was made, and the patient was admitted to the Mount Sinai Hospital on the following day for observation and study.

The patient had spent the five weeks prior to his present illness (February and the early part of March) in Florida, and during his sojourn there he had been in excellent health. Two days after his return sharp pain developed in both eyes, the pain being more marked in the right eye. A few days later vision became blurred, and the patient became aware of a defect in the temporal portion of the field in the right eye. About three years before he had suffered with acute sinusitis. The tonsils were removed at that time; and treatment of the right antrum improved the condition. Since then he had had several attacks characterized by sharp pain in the right superciliary region, which cleared up under nasal treatment. About ten months before he was seen, because of this pain he had been fitted with glasses by an optometrist.

Apart from his ocular discomfort he was in excellent health and was well nourished and well developed. There was no evidence of pituitary dysfunction There was no polydipsia and no polyuria. The olfactory sense was unimpaired. The Wassermann test, the chemical analysis of the blood and the neurologic examination gave normal results.

Roentgen examination showed that the anteroposterior diameter of the sella turcica measured 15 mm.; the depth was 10 mm. The dorsum sellae showed definite sharpening at the tip (fig. 2). The sinuses were reported to be clear and to show no abnormalities.

The visual fields on April 4, 1934, showed a marked expansion of the bitemporal scotoma with an increase in the peripheral contraction. There was a complete bitemporal hemianopia for colors, and vision in the left eye was reduced from 20/40 to 20/70 (fig. 3).

The patient said that he had been engaged in the distribution of alcoholic beverages but that he was not addicted to excessive smoking or drinking, though he occasionally indulged in smoking narcotics, such as opium and mariahuana cigarets. Because of this and of the scotomatous nature of the fields the possibility of a toxic amblyopia was given due consideration.

However, the headaches and visual disturbances became progressively worse in spite of eliminative treatment and of the withdrawal of all toxic agents since the patient's admission to the hospital. It was clear that there was a rapidly expanding

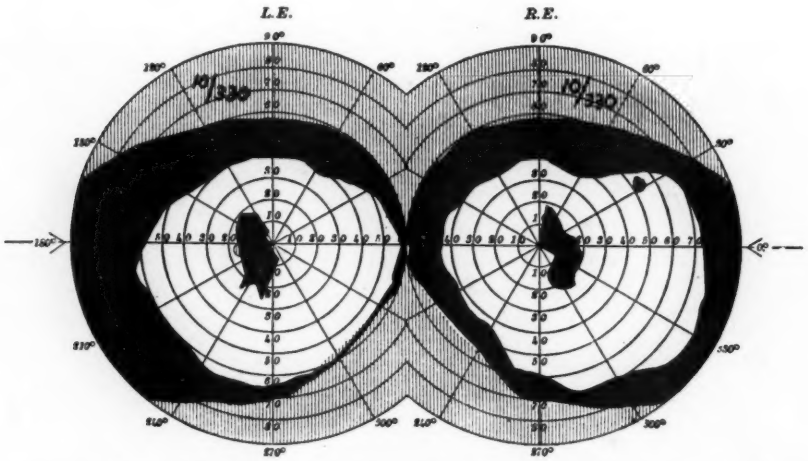

Fig. 1.—Visual fields on March 27, 1934, showing bitemporal hemianopic paracentral scotoma. Vision in the left eye was 20/40, and in the right eye, 10/200.

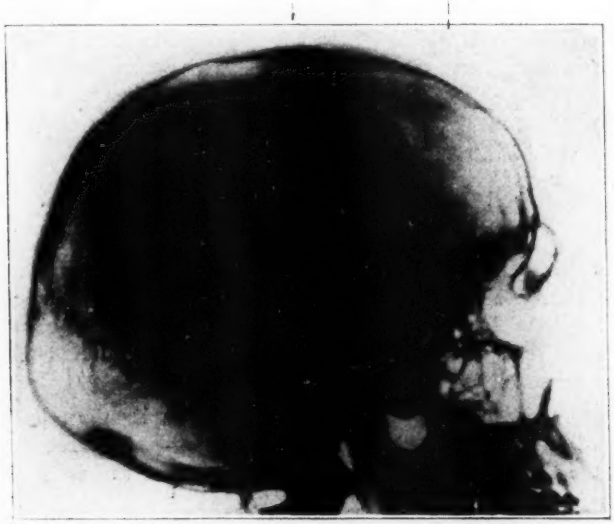

Fig. 2.—Roentgenogram showing enlargement of the sella with sharpening of the dorsum sellae at the tip in a case of arachnoid cyst.

lesion mechanically affecting the chiasm. A lumbar puncture was made on April 10. The pressure of the spinal fluid was 425 mm. of water. The puncture temporarily relieved the headache, and the patient expressed the belief that his vision was also improved. Meanwhile, however, the bitemporal field defects were seen to have rapidly progressed to a complete hemianopia (fig. 4). Two days later

(April 12) the field in the left eye (originally the better eye) was entirely blotted out, and vision was reduced to perception of light. In the right eye (the eye originally more affected) vision was still 10/200, and there was

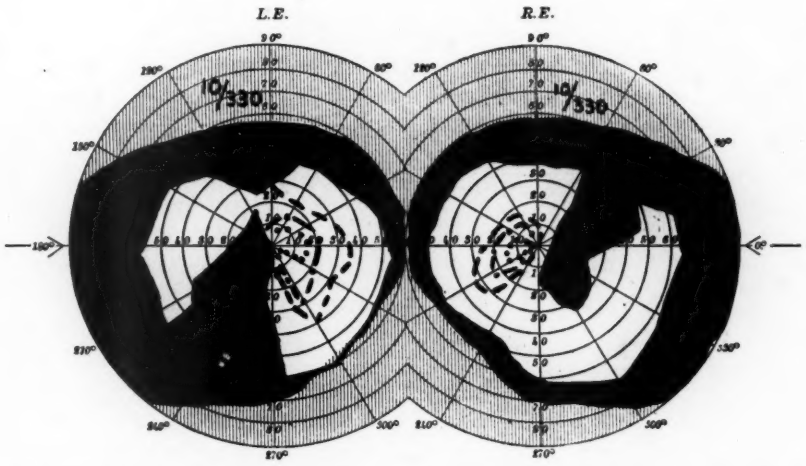

Fig. 3.—Visual fields on April 4, 1934, showing expansion of the scotoma upward and outward in the right eye and downward and outward in the left eye, with complete bitemporal hemianopia for colors. The dotted line indicates hemianopia for green; the dot-dash line, hemianopia for red, and the dash line, hemianopia for blue. On that date vision in the left eye was 20/70 —1, and in the right eye, 10/200.

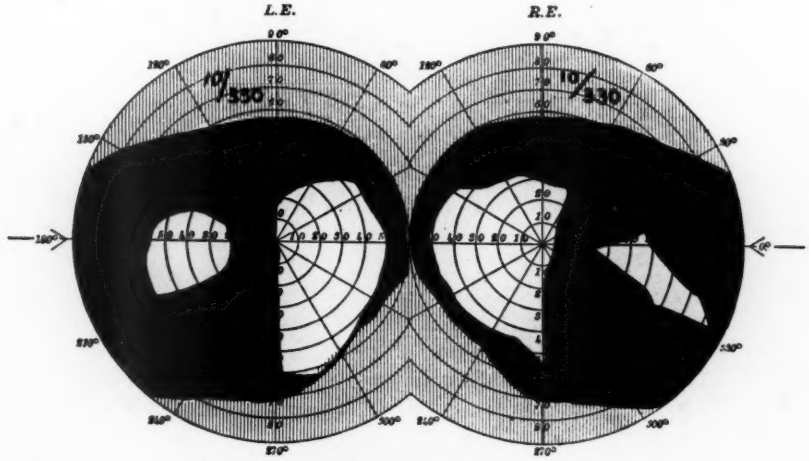

Fig. 4.—Visual fields on April 7, 1934, showing rapid progress of the bilateral hemianopia. Vision in the left eye was 20/100, and in the right eye, 10/200.

preservation of a constricted nasal field, although this, too, was rapidly disappearing (fig. 5). The left pupil was slightly larger and reacted to light less readily than the right.

The eyegrounds remained apparently normal, although there seemed to be a little whitening of the deeper layers in the temporal half of either nerve head. Without the patient's visual record, however, they would undoubtedly have been regarded as normal.

Operation.—Operation was performed on April 14, 1934, by Dr. Francis C. Grant. Avertin and procaine hydrochloride were given as anesthetics, and a flap of bone in the right frontal region was thrown back according to the usual method; no difficulty was encountered. The brain was rather tight. There was a great deal of fluid in the subarachnoid spaces. The dura was opened and the fluid drained. The surface of the brain was apparently normal. The frontal lobe was elevated, and a shiny, cystic tumor that apparently arose from the pituitary fossa beneath the chiasm was found in the embrace of the optic nerves, pressing against the anterior part of the chiasm. The nerves appeared to be under tension, and the left nerve was flattened. The wall of the cyst was so thin that it resembled an arachnoid cyst. The cyst was tapped and about 10 cc. of clear fluid was withdrawn.

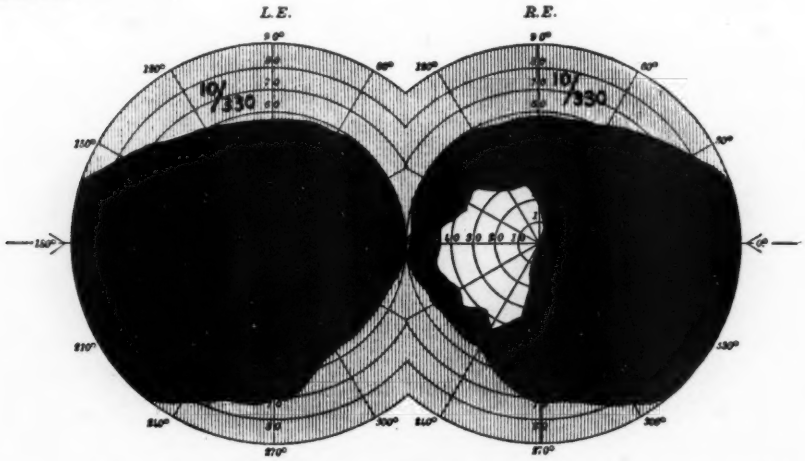

Fig. 5.—Visual fields on April 12, 1934, showing loss of the entire field in the left eye with preservation of a constricted nasal field in the right eye. Vision in the left eye was reduced to perception of light; in the right eye vision was 10/200.

The cyst collapsed. Its wall was then seized with pituitary rongeurs in order to secure a piece for histologic examination, but on gentle pulling the whole cyst apparently came out. This, fortunately, did not cause bleeding. The bed of the cyst was packed with pledgets soaked in epinephrine, and the frontal lobe was allowed to fall back. After precautions for hemostasis of the wound had been taken the pledgets were removed from the cyst bed. There was no evidence of bleeding. The dura was tightly closed, and after careful provisions for extradural hemostasis had been made the flap of bone was replaced and the skin closed in layers in the usual manner, a stab wound to allow for drainage being made behind the posterior limb of the flap.

Postoperative Course.—The patient's condition at the end of the operation was fair, but the blood pressure was somewhat below normal, and the pulse rate was rapid. Administration of 150 cc. of 50 per cent dextrose did not have much effect. The condition did not improve, and at about 8 p. m. a transfusion of 300 cc. of blood was given with no beneficial results. The temperature was 104 F. by axilla; the pulse rate was 160; the beat was imperceptible at the wrist, and the blood pressure

remained low. The skin was cold and clammy, but the patient had regained consciousness and responded, although rather feebly, to commands. He remained in that condition all night. The next day he showed no improvement, and he was given two additional blood transfusions without benefit. Inspection of the wound revealed no bleeding. The temperature rose to 106 F., and the blood pressure could not be measured. Breathing became rapid and irregular. The patient died of vasomotor collapse about twenty-four hours after the operation.

Fig. 6.—Photomicrograph of a section from the suprasellar arachnoid cyst.

Postmortem Examination.—The postmortem examination was limited to the brain. The surface of the brain was normal in size. There was no evidence of increased pressure. The sulci and gyri were entirely normal. The only evidence of abnormality that could be seen on the surface of the brain had to do with the optic chiasm. The arachnoid over the chiasm was thickened. The chiasm was angulated from left to right. The right optic nerve was larger and thicker than normal, and the left was flattened. There seemed to be no distortion of any other cranial nerves. No lateral hydrocephalus, no ventricular shift and no evidence of

any tumor behind the optic nerves in the third ventricle was present. There was no evidence of hemorrhage at any point in the brain. The pituitary gland appeared normal in size. The infundibulum could not be made out.

On April 16, 1934, Dr. B. J. Alpers examined the cyst and gave the following description of the gross specimen: "The specimen consists of a cyst wall 3 cm. long and 1.5 cm. wide. It is white, translucent and, in many places, transparent. It is delicate and tears easily. One end is broad; the other tapers and is considerably narrower. There are no blood vessels or nerves in the wall. In addition there is a small piece of solid tissue which is firm and whitish gray. Its nature cannot be definitely identified."

The microscopic description was as follows: "The capsule is composed of a fibrous tissue base which occupies about one third of the thickness of the capsule. Above it are several layers of cells which are laminated. They show no characteristic arrangement. The cells are composed of large round or crescentic nuclei which stain darkly. Often the nuclei lie in what appears to be a capillary wall, giving a capillary appearance to the cell. The cell membrane seems to be quite clear in many of the cells. The cytoplasm has a finely granular appearance and stains a rather intense pink. There is a delicate reticulum among the cells which can be identified by Laidlaw's connective tissue stain. No fibroglia is seen. Near the surface there is a layer of flattened cells lining the inner surtace of the cyst. This is not seen everywhere. In some places the inner surface shows desquamating cells which are very large and exhibit large, vesicular nuclei and abundant cytoplasm. Here and there along the cyst wall are collections of small cells similar in structure to those seen in the wall itself. They have round, pyknotic nuclei and a large amount of cytoplasm. There are many large spaces, some of which appear to be lined with flattened endothelium. There is a fine reticulum among the cells (fig. 6). The diagnosis is arachnoid cyst."

COMMENT

Apart from its importance from the neurosurgical standpoint this uncommon case is interesting and is presented chiefly because of changes in the visual field. In many instances when the patient presents himself for examination the vision has been so deteriorated as to render perimetric studies impossible. Not infrequently one eye has already become totally blind; the bitemporal character and progress of the field defects cannot be properly interpreted and are of little or no diagnostic help. This case afforded an opportunity to observe the evolution of a bitemporal hemianopia from the first to the last stage.

The scotomatous character of the fields is an interesting feature from the standpoint of preoperative localization of the lesion. In medially placed suprasellar tumors the bitemporal hemianopia usually begins with a defect of the upper temporal quadrant which progresses downward and inward, clockwise in the right eye and counterclockwise in the left eye. In this case, although there was some peripheral contraction, the outstanding feature was the bitemporal scotoma expanding with unusual rapidity and blotting out the fields from within outward rather than from without inward, the involvement proceeding upward and outward in the right eye and downward and outward in the left

eye (fig. 3). If, as it is claimed, the crossed macular fibers are located in the posterior part of the chiasm, it must be assumed that the primary pressure exerted by the cyst was directed from below upward against the midsection of the posterior chiasm until it emerged from its confines beneath the chiasm into the open space between the optic nerves. Then it filled up rapidly and pressed on the anterior chiasm and on the nerves themselves, thus producing the rapid and atypical progress of the field defects.

Unfortunately, the origin of the cyst could not be definitely determined at autopsy. De Schweinitz,[1] in his Bowman lecture, speaking of the relationship between the chiasm and the diaphragma sellae, quoted Schaffer's researches as follows:

> It was found that the space between the basal surface of the optic chiasma and the upper surface of the diaphragma and the hypophysis varied from a potential cleft (actual contact of parts) to a vertical interval of 10 mm. Strictly defined, the actual membrane which forms the immediate limits of this space is arachnoidal (pia arachnoidal according to another concept), the lower part being in actual contact with the dural diaphragm.

Apparently the cyst in this case arose from the subchiasmal arachnoid membrane. However, at operation the cyst was found to lie anteriorly to the chiasm, which was distorted, and to be encircled by the optic nerves, which also showed evidence of compression. The question arises: Was the cyst entirely prechiasmal, and were all the chiasmal field defects produced by frontal pressure alone? This possibility has been emphasized by Cushing,[2] who stated:

> In the production of a chiasmal syndrome the block to visual impulses producing the bitemporal hemianopsia need not necessarily be restricted to the bundles as they pass across the chiasm. For in the case of posteriorly placed tumors, the effect may be produced by pressure involvement of these same bundles in the optic tracts just as in anteriorly placed tumors it may be the crossed bundles in the nerves themselves that suffer.

The unusually rapid progress of the condition is a point worth noting from the standpoint of preoperative diagnosis as to the type of lesion. The patient was perfectly well and had no ocular complaints until about two weeks before his admission to the hospital; during the two weeks he was under observation complete blindness developed in the left eye and nothing but a small nasal field remained in the right eye. As the condition progressed, it became increasingly apparent that

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1. de Schweinitz, G. E.: Concerning Certain Ocular Aspects of Pituitary Body Disorders, Mainly Exclusive of the Usual Central and Peripheral Hemianopic Field Defects, Tr. Ophth. Soc. U. Kingdom **43**:12, 1923.

2. Cushing, Harvey: The Chiasmal Syndrome, Arch. Ophth. **3**:505 (May); 704 (June) 1930.

the changes in the fields were due to pressure and that the symptoms were caused by a rapidly expanding tumor.

It would be unusual for a solid tumor, even of the progressive type, to produce such rapid changes. Nor is it likely that a vascular lesion or an arachnoiditis would cause the fields to be blotted out so rapidly. It is quite conceivable, however, that a suprasellar or parasellar cyst rapidly filling up and pressing on the nerves and chiasm could bring about such rapid changes.

It is also interesting to note the disproportion between the field defects and the ophthalmoscopic findings. Even after the fields were entirely blotted out, the eyegrounds remained essentially normal. This shows that while vision may be lost, actual atrophy of the optic nerve fibers does not take place until they have been under pressure for some time. Cushing and Walker [3] said:

> A study of the fields before and after operation gives considerable evidence that atrophy of the visual fibres does not necessarily take place until they have been under pressure sufficient to block their function for six months or a year, or even longer.

This young man's death was an unfortunate occurrence. Had he recovered, his visual fields and acuity would in all probability have returned to normal.

The cause of death was problematic. The operation was performed with a minimum of trauma, and the time was not unusually long (about three hours). Section of the brain by Dr. Alpers revealed evidence of a slight hemorrhage into the wall of the third ventricle. This hemorrhagic area was microscopic but was apparently sufficient to cause a vasomotor collapse, hyperthermia and death.

In conclusion it may be worth pointing out that a correct preoperative localization of the lesion was made entirely from the perimetric findings. This serves to emphasize what has frequently been stressed in recent years by authors like Cushing,[2] de Schweinitz [4] and others, namely, the increasingly important rôle which perimetry has come to play in ophthalmology in general, and in neurosurgery in particular.

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3. Cushing, H., and Walker, C. B.: Chiasmal Lesions, with Reference to Bitemporal Hemianopsia, Brain **37**:341, 1915.

4. de Schweinitz, G. E.: Address Before the Wills Hospital Society Annual Meeting, Philadelphia, Dec. 9, 1934.

DISPOSITION OF FIBERS OF RETINAL ORIGIN IN THE LATERAL GENICULATE BODY

COURSE AND TERMINATION OF FIBERS OF THE OPTIC SYSTEM IN THE BRAIN OF THE CAT

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CHICAGO

The manner of ending of crossed and uncrossed fibers of the optic tract in the lateral geniculate body has received comparatively little attention, although the projection of the various quadrants of the retina on the lateral geniculate body has been thoroughly investigated (Brouwer,[1] Brouwer and Zeeman,[2] Overbosch,[3] Le Gros Clark and Penman[4] and others). Minkowski[5] was the first to demonstrate that there was a separation of retinal fibers of crossed and those of uncrossed origin in the lateral geniculate body in a number of animals. This he found to be true in the rabbit, cat, goat and monkey. He was able to show that in consequence of the removal of one eye, the animal being allowed to live for several weeks before it was killed, a chromatolytic degeneration of the cell bodies in certain of the cellular layers in the lateral geniculate body resulted. By comparing the appearance of the lateral geniculate bodies of the two sides, he was able to demonstrate

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* National Research Council Fellow.

From the Institute of Neurology, Northwestern University Medical School.

1. Brouwer, B.: Experimentelle-anatomische Untersuchungen über die Projection der Retina auf die primären Opticuszentren, Schweiz. Arch. f. Neurol. u. Psychiat. **13**:118, 1923.

2. Brouwer, B., and Zeeman, W. P. C.: Experimental Anatomical Investigations Concerning the Projection of the Retina on the Primary Optic Centers in Apes, J. Neurol. & Psychopath. **6**:1, 1925.

3. Overbosch, J. F. A.: Experimentel-anatomische onderzoekingen over de projectie der retina in het centrale zenuwstelsel, Inaug. Dissert., Amsterdam, H. J. Paris, 1927; cited by Brouwer, B.: The Herter Lectures of Johns Hopkins University, Baltimore, Williams & Wilkins Company, 1926, vol. 17.

4. Clark, W. E. L., and Penman, G. G.: The Projection of the Retina in the Lateral Geniculate Body, Proc. Roy. Soc., London, s.B **114**:291, 1934.

5. Minkowski, M.: (*a*) Experimentelle Untersuchungen über die Beziehungen der Grosshirnrinde und der Netzhaut zu den primären optischen Zentren, besonders zum Corpus geniculatum externum, Arb. a. d. Hirnanatomische Inst. Zürich **7**:104, 1913; (*b*) Ueber den Verlauf, die Endigung und die zentrale Repräsentation von gekreuzten und ungekreutzen Sehnervenfasern bei einigen Säugetieren und beim Menschen, Schweiz. Arch. f. Neurol. u. Psychiat. **6**:201, 1920.

that the fibers which remained uncrossed in the chiasma entered one set of cellular laminae and the fibers which crossed entered another set.

Le Gros Clark [6] recently reported his observations on the disposition of fibers of retinal origin in the lateral geniculate body of man. Henschen [7] had previously reported three cases in which certain of the cellular laminae of the human lateral geniculate body showed visible

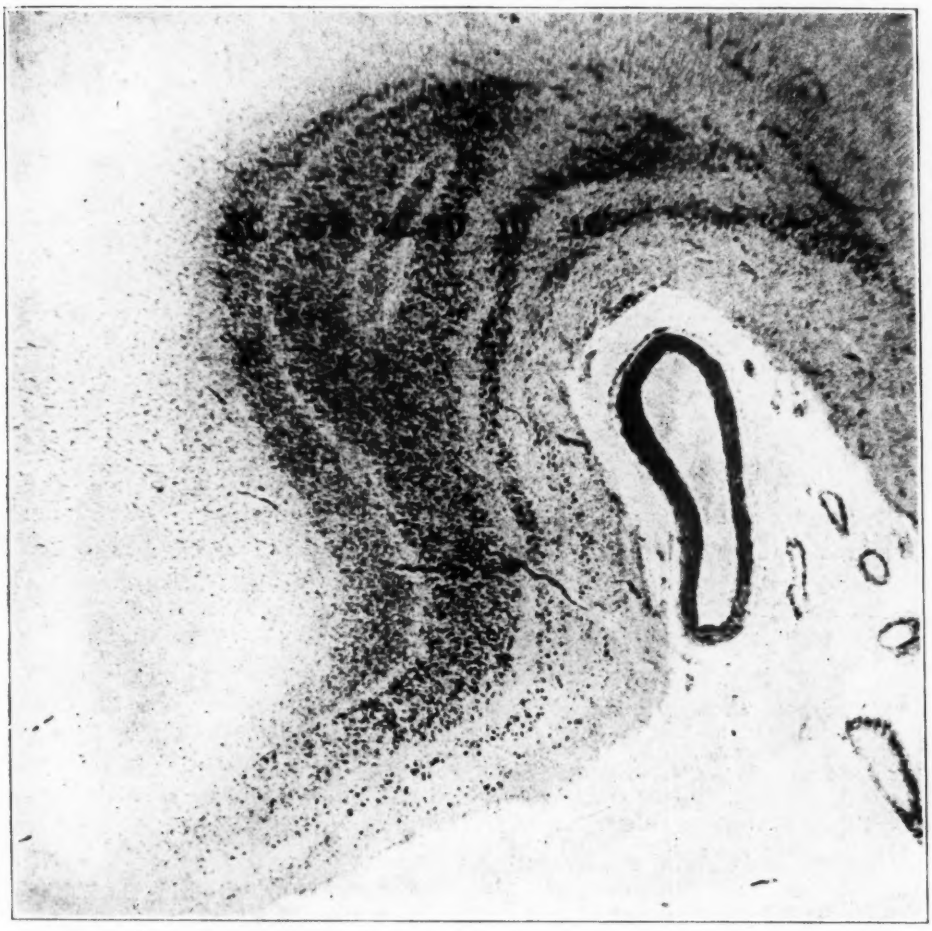

Fig. 1.—Left lateral geniculate body of a man whose right eye had been removed some time prior to death. Laminae *1C*, *2C* and *3C*, which receive optic fibers from the contralateral eye, are atrophied. Laminae *1D*, *2D* and *3D* receive optic fibers from the homolateral eye and appear normal. Cresyl violet stain; low power magnification.

6. Clark, W. E. L.: A Morphological Study of the Lateral Geniculate Body, Brit. J. Ophth. **56**:264, 1932.

7. Henschen, S. E.: Die Vertretung der beiden Augen in der Sehbahn und in der Sehrinde, Arch. f. Ophth. **117**:419, 1926.

alteration in their appearance following enucleation of one eye. I recently obtained the brain of a man whose right eye had been removed some time prior to death.[8] The observations on the lateral geniculate bodies of this specimen confirm the earlier observations of Henschen and Le Gros Clark. I wish to present here the results of the

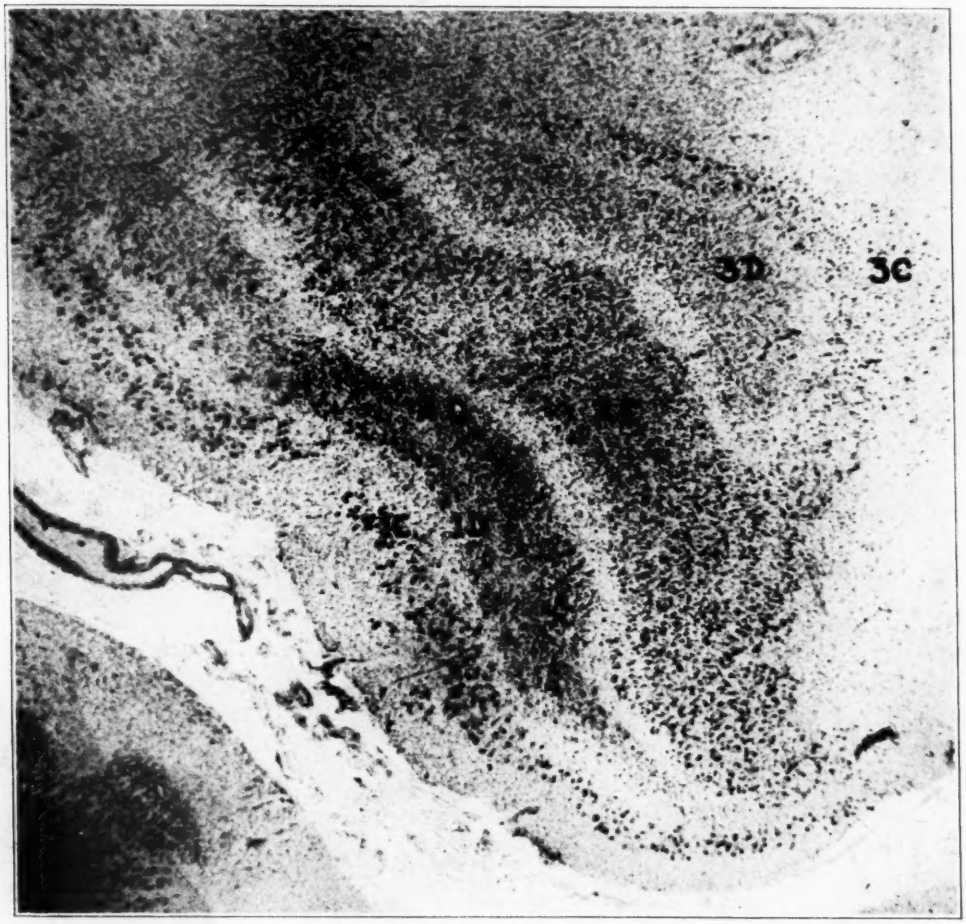

Fig. 2.—Right lateral geniculate body obtained from the same brain as the geniculate body shown in figure 1. Laminae *1C*, *2C* and *3C* appear normal, as these laminae receive fibers from the contralateral eye. On the other hand, laminae *1D*, *2D* and *3D* appear atrophied in consequence of removal of the homolateral eye. Cresyl violet stain; low power magnification.

study together with some observations which were made on the lateral geniculate body of the cat.

8. Dr. J. P. Simonds of the department of pathology of Northwestern University Medical School permitted me to use this specimen.

In the normal human lateral geniculate body there may be seen six cellular laminae; the four deepest ones are rather wide layers containing cells of medium size, and the two more superficial laminae are narrow and contain large, deeply staining cells. For purposes of illustration, the cellular laminae, beginning with the most superficial large cell layer and progressing inward toward the deepest medium-sized cell layer, have been designated as follows (figs. 1 and 2): *1C, 1D, 2D, 2C, 3D* and *3C*. The letter *C* or *D* added as a suffix to the numeral indicates that the cellular lamina receives fibers from the contralateral retina (crossed) and from the homolateral retina (direct), respectively.

In the left lateral geniculate body of the specimen studied (fig. 1), laminae *1C, 2C* and *3C* appeared less prominent than laminae *1D, 2D* and *3D*. The cell bodies within layers *1C, 2C* and *3C*, when examined under the microscope, appeared atrophied, being in no observable way different in appearance from the cell bodies of *1D, 2D* and *3D* except for their smaller size. The atrophy of the affected cells was not accompanied by the destruction of specific cellular constituents, the amount of cytoplasm being diminished. Tigroid or Nissl bodies were present, and the nucleus, which contained a chromatin network, maintained its central position within the cytoplasm. This type of atrophy may be conveniently termed "atrophy of disuse," as these cell bodies have been deprived of their stimuli in consequence of the removal of one eye, or "transneural atrophy," as one neuron has atrophied in consequence of the degeneration of another neuron which normally effects a synapse with it.

In the right lateral geniculate body of the specimen studied (fig. 2), laminae *1D, 2D* and *3D* exhibited the same appearance as laminae *1C, 2C* and *3C* in the left lateral geniculate body (fig. 1); laminae *1C, 2C* and *3C* of the right lateral geniculate body, however, appeared normal. In other words, those laminae which were atrophied in the left lateral geniculate body were normal in appearance in the right lateral geniculate body, and vice versa. This alternation of atrophied and normal cellular laminae in the lateral geniculate bodies after removal of one eye is, as we interpret it, in agreement with Minkowski, Henschen and Le Gros Clark, evidence that fibers of retinal origin are disposed in the lateral geniculate bodies in such manner that fibers from the homolateral eye establish synapses in one set of cellular laminae (*1D, 2D* and *3D*), while fibers from the contralateral eye end in another set of cellular laminae (*1C, 2C* and *3C*).

DISPOSITION OF FIBERS OF RETINAL ORIGIN IN THE LATERAL GENICULATE BODY OF THE CAT

In the cat, the dorsal nucleus of the lateral geniculate body is the homolog of the lateral geniculate body of man. It receives fibers from

the homolateral and the contralateral eye, the number of fibers from the latter predominating. Minkowski [5] has been able to show that in the cat the crossed fibers are disposed in one set of cellular laminae and the uncrossed fibers in another set.

The dorsal nucleus of the lateral geniculate body of the cat consists of several cellular layers, as illustrated in figure 3*A*. Rioch [9] studied the histologic features of this nucleus and employed a terminology which I have used here. From the diagram (fig. 3*A*) it is evident that there are four main layers in the dorsal nucleus of the lateral geniculate body of the cat. Associated with this structure is another layer of cells which lies in close proximity to the rostral and dorsal margins of this nucleus; this has been called by Rioch the substantia grisea pregeniculata (*SGP*). At the level shown here, the four layers of the lateral geniculate body

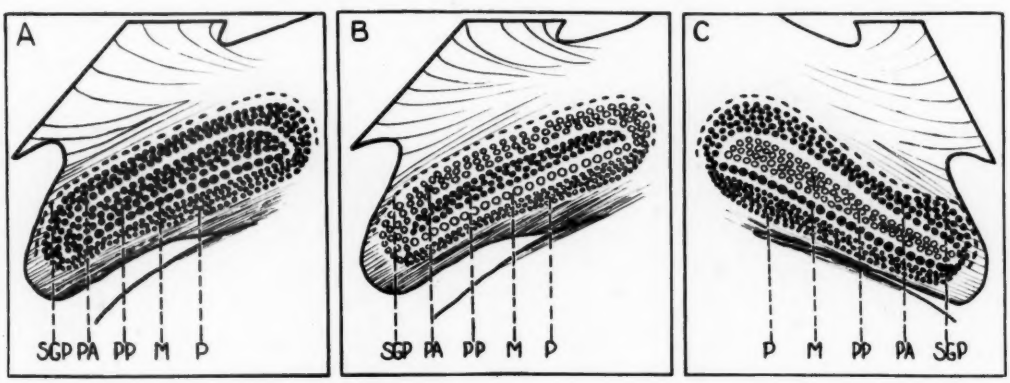

Fig. 3.—*A*, diagrammatic drawing of the left dorsal nucleus of the lateral geniculate body of a cat, showing various cellular laminae of which the normal geniculate is composed. *SGP* indicates substantia grisea pregeniculata; *PA*, pars anterior; *PP*, pars posterior; *M*, pars magnocellularis; *P*, pars parvocellularis. *B*, diagrammatic drawing of the left dorsal nucleus of the lateral geniculate body of a cat from which the right eye had been removed. Laminae *PA*, *M* and *P* show atrophy. Lamina *PP* appears normal. *C*, diagrammatic drawing of the right dorsal nucleus of the lateral geniculate body of the cat from which the right eye had been removed. Laminae *PA*, *M* and *P* appear normal. Lamina *PP* shows atrophy.

proper may be seen lying one on top of the other. The most dorsal cell layer has been called the lamina principalis anterior (*PA*); directly beneath this lies a similar layer of cells, the lamina principalis posterior (*PP*). The lamina principalis anterior and lamina principalis posterior are composed of large, medium-sized and small cells. Directly below

9. Rioch, D. McK.: Studies on the Diencephalon of Carnivora: I. The Nuclear Configuration of the Thalamus, Epithalamus and Hypothalamus in the Dog and Cat, J. Comp. Neurol. **49**:1, 1929.

the lamina principalis posterior is a thin, somewhat irregular layer of large cells, the lamina magnocellularis (*M*). Most ventrally lies a layer composed of small cells, the lamina parvocellularis (*P*). In the normal lateral geniculate body stained with cresyl violet, each of these layers may be made out rather easily, the cells of which they are composed staining fairly uniformly.

In some recent studies which have been made of the brain of the cat after removal of one eye, the Marchi method of staining being used, it was observed that the lateral geniculate bodies of the two sides showed a difference in the manner of disposition of crossed and uncrossed fibers of retinal origin. This material was not suitable for making observations relative to the precise cellular laminae in which crossed or uncrossed fibers terminated. It was therefore decided to perform a series of experiments in which one eye was removed and to stain the material with a stain suitable for demonstrating any cellular changes which might occur in the geniculate bodies. Four animals were used; the left eye was removed from two of them (nos. 2 and 5) and the right eye from the other two (nos. 1 and 4). Cats 1, 2, 4 and 5 were killed sixty-two, sixty-one, forty-eight and thirty-five days, respectively, after the day of operation. The brains were fixed in solution of formaldehyde, embedded in paraffin, sectioned, stained with cresyl violet and mounted.

Figure 3*B* is a diagram showing the appearance of the left lateral geniculate body as it was seen in those animals from which the right eye had been removed. The cell bodies of the lamina principalis anterior (*PA*), lamina magnocellularis (*M*) and lamina parvocellularis (*P*) showed a moderate degree of atrophy, this amounting to no more than a diminution of the amount of cytoplasm of the respective cell bodies within the affected layers. On the other hand, the lamina principalis posterior (*PP*) showed no alteration from its appearance in normal animals. The right lateral geniculate body (fig. 3*C*) in the same animals from which the right eye had been removed exhibited a normal appearance of its cellular laminae with the exception of the lamina principalis posterior (*PP*). This layer of cell bodies presented features identical with those of the layers showing atrophy in the lateral geniculate body of the opposite side.

After removal of the left eye, the left and right lateral geniculate bodies, respectively, presented an appearance which was opposite to the appearance of the left and right lateral geniculate bodies after removal of the right eye. Those layers of the left lateral geniculate body which showed atrophy after removal of the right eye were unaffected after removal of the left eye, and vice versa. These observations are interpreted to mean that in the cat the cell bodies of the laminae principalis anterior, magnocellularis and parvocellularis receive fibers from the

retina of the contralateral eye and that the lamina principalis posterior receives fibers from the retina of the homolateral eye.

In the cat, another nucleus, the ventral nucleus of the lateral geniculate body, is to be seen interposed among the fibers of the optic tract just before this tract breaks up to encapsulate the dorsal nucleus. This nucleus does not appear at the level represented in the diagrams (fig. 3). The cell bodies of the ventral nucleus are for the most part of small size with a sprinkling of medium-sized cells. In my material it does not appear that any of these cell bodies undergo atrophy in consequence of the removal of one eye. Minkowski,[5b] in his observations on the ventral nuclei of the lateral geniculate bodies of two cats from each of which one eye had been removed, reported that in only one case did he observe atrophy of a small number of cells in this structure, and it was on the side contralateral to the enucleated eye.

COMMENT

The foregoing review completes a study begun by my associates and me some time ago on the relationship of the various fibers of the optic system to the midbrain and the diencephalon. A full account of this work will be published elsewhere.[10] A brief summary of the essential results of our investigation with reference to the optic pathways and the course and termination of the various fiber constituents of the optic system may not be inappropriate here. Reference to figure 4 will facilitate the reader in his interpretation of the following brief résumé of our observations.

Four series of experiments were performed, each series being designed to yield information relative to one or more of the constituents of the optic system.

1. In the first series, one eye was removed from each of five cats, and both eyes were removed from each of two cats. In this manner we were able to interrupt the optic nerve at its point of exit from the eyeball and to produce degeneration of the primary optic pathways. After a postoperative period of from nine to eleven days the animals were killed, and the mesencephalic and diencephalic regions of the brain stem were prepared for study by the Marchi staining technic. From this material we were able to demonstrate certain facts with reference to the course and termination of fibers of retinal origin within the diencephalic and mesencephalic regions of the brain stem. These facts may be summarized as follows (fig. 4):

From the retinas of both eyes optic nerve fibers pass into the optic tract after partial decussation in the optic chiasma. Both crossed and

10. Barris, R. W.; Ingram, W. R., and Ranson, S. W.: Optic Connections of the Diencephalon and Midbrain of the Cat, J. Comp. Neurol., to be published.

uncrossed fibers establish connections with: (*a*) the dorsal nucleus of the lateral geniculate body; (*b*) the rostral part of the pretectal area, retinal fibers reaching this area by way of the brachium of the superior colliculus and the stratum zonale of the thalamus, and (*c*) the superior colliculus, retinal fibers reaching the dorsal portion of the stratum opticum by way of the brachium of the superior colliculus.

No evidence was found for the termination of the fibers of the optic tract in the ventral nucleus of the lateral geniculate body, the

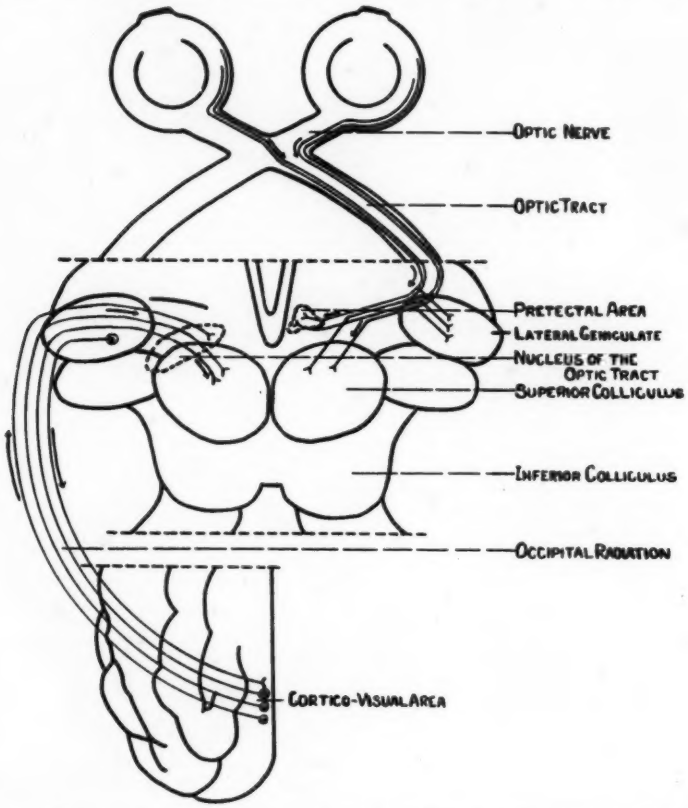

Fig. 4.—Diagram showing the optic connections of the midbrain and the thalamus of the cat. This concept is based on the results obtained in studies of the brain of the cat after lesions were produced in the visual area of the cerebral cortex and in the lateral geniculate body and after enucleation of one or both eyes. Marchi staining technic.

nucleus of the optic tract (nucleus lentiformis mesencephali), the pulvinar, pars posterior pulvinaris or the nucleus of the posterior commissure. No fibers of retinal origin were found crossing in the posterior commissure or in the midline between the superior colliculi. The anterior and posterior accessory optic tracts could not be identified.

2. In a second series of experiments, both eyes were removed from each of nine cats. After a period of from six to eight months, during

which time the primary optic fibers had undergone complete atrophy, each animal was again operated on, and a small lesion was placed in the dorsal nucleus of the lateral geniculate body with the aid of the Horsley-Clarke stereotaxic instrument. In this way we were able to obtain a secondary degeneration of fibers the cells of origin of which were in the lateral geniculate body and to determine whether or not fibers from this nucleus passed to regions of the brain other than the visual cortex. At an interval of from nine to eleven days after the last operation the animals were killed, and their brains were prepared for study by the Marchi staining technic. The results of our observations indicate that fibers the cell bodies of which lie within the dorsal nucleus of the lateral geniculate body pass exclusively to the cerebral cortex. We found no evidence for the existence of geniculotectal, geniculopretectal, geniculopulvinar or geniculothalamic connections.

3. In a third series of experiments, a portion of the right visual or striate area of the cerebral cortex was removed in each of six cats. In this way we were able to destroy the cells of origin of some of the corticotectal fibers and of any other corticifugal fibers the cells of origin of which might lie within the circumference of the area in which the lesion was located. From nine to eleven days later the animals were killed, and the brains were prepared by the Marchi method.

4. In a fourth series of experiments, a part of the right parastriate area was removed from each of three cats. The animals were allowed to live for from nine to eleven days after operation; they were then killed, and the brains were prepared by the Marchi technic.

On the basis of our examination of the material obtained from the third and fourth series of experiments, we came to the conclusion (*a*) that corticifugal fibers from the striate and parastriate areas of the cerebral cortex pass to the nucleus of the optic tract (nucleus lentiformis mesencephali), the ventral portion of the stratum opticum of the superior colliculus [11] and the pontile nuclei (by way of the transverse peduncular tract); (*b*) that corticifugal fibers from the striate and parastriate areas do not terminate in the pulvinar, the posterior part of the pulvinar, the pretectal area, the posterior part of the lateral nucleus of the thalamus, the posterior thalamic nucleus or the dorsal and ventral nuclei of the lateral geniculate body.

11. The nucleus of the optic tract (fig. 4) is a lens-shaped mass of large cells more or less continuous with the pretectal area and lying rostral of the superior colliculus. The fibers of the brachium of the superior colliculus are intimately related to this nucleus, but the results of our study indicate that only fibers of cortical origin establish synapses here. Fibers arising in the superior colliculus, i. e., tectospinal and tectobulbar fibers, make possible the turning of the head and body in response to stimulation of retinal elements.

In the course of this investigation the interesting observation has been made that fibers of the optic tract may form synaptic connection with cells of the lateral geniculate body in part at least by means of collateral fibers. In a careful study of material stained by the pyridine silver method such collaterals may be seen to arise almost at right angles to their parent fibers, the latter passing onward toward the tectum of the midbrain. This observation allows us to conclude that from an anatomic standpoint it is possible for a single impulse of retinal origin not only to pass to the visual cortex (by way of the lateral geniculate body) but to pass mediad to the superior colliculus and the pretectal area. Retinal impulses which pass to the cortex after passing through the geniculate body may also eventually reach the superior colliculus by way of corticifugal fibers. It is conceivable that the same impulse might reach the superior colliculus without first passing by way of the visual cortex. Just what this means from a functional point of view is enigmatic, but that this possibility does exist seems sufficiently important to mention here.

We have also been able to demonstrate that the pretectal area, which occupies a position near the midline between the caudal part of the diencephalon and the rostral part of the midbrain, receives fibers of retinal origin. Thus far, however, there seems to be no evidence that this nuclear area receives fibers from the visual area of the cortex. That fibers from the retina mediating constriction of the pupil reach the pretectal area has been demonstrated by Ranson and Magoun.[12] Whether these fibers form collateral connections with the lateral geniculate body is not certain, but it is unlikely in view of the fact that stimulation of the lateral geniculate body does not produce a constriction of the pupils (Ranson and Magoun [12]).

12. Ranson, S. W., and Magoun, H. W.: The Central Path of the Pupilloconstrictor Reflex in Response to Light, Arch. Neurol. & Psychiat. **30**:1193 (Dec.) 1933.

NEURINOMA OF THE ORBIT

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NEW YORK

The following case of orbital tumor is reported for two reasons. First, the operative results were good. The vision and mobility of the eyeball were preserved in normal condition, and the cosmetic result was excellent, as exophthalmos disappeared and no scar was noticeable three months after the operation. Second, although the clinical diagnosis of orbital tumor was easy since all the signs and symptoms were typical, the atypical histologic structure of the tumor presented great difficulties in diagnosis because the character of the tissue was not clearly differentiated. There was much discussion among pathologists. The main mass of the tumor was composed of cellular connective tissue, so that the diagnoses of neurofibroma, neurinoma and fibroma, respectively, were made by different pathologists. On the other hand, vascularization was so extensive that it led some pathologists to call the tumor hemangioma or fibrohemangioma.

REPORT OF A CASE

History.—Mrs. C. M., aged 28, white, was first seen in my office on July 10, 1932. She complained of blurring of vision and occasional pain on motion and bulging of the right eye for the past year. There had been no headache or vertigo.

Past Ocular History: The patient had worn glasses for the correction of near sight since childhood; they had always been prescribed by an oculist. For the past two years there had been frequent changes of the right lens because of blurred vision; the last lens, as stated by the oculist, was prescribed for the correction of far sight. (The prescription in 1921 was —2.50 cyl., axis 15°; in 1931 the same oculist prescribed for the right eye a +1.50 sph.)

Past General History: The general health had been good; the patient had pneumonia at the age of 17, and her tonsils and adenoids were removed at that time. Five years prior to examination she met with an automobile accident, when she fell and hurt the left side of the head. Four years before a rather sudden enlargement of the thyroid gland appeared, which gradually subsided without medication.

Family History: The family history was unimportant; the patient's mother when a girl had proptosis of the right eye. She had been seen by several ophthalmologists, who could do nothing for her; the bulging gradually subsided, and the eye was well at the time I first saw the patient.

Physical Examination.—The lids of the right eye were slightly puffed, and the bulbar conjunctiva was mildly injected. The eye was moderately proptosed directly forward. The mobility of the eyeball was good in all directions. There

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The patient was presented before the Section of Ophthalmology of the New York Academy of Medicine, Dec. 19, 1932.

was resistance to backward pressure on the eyeball; no definite pulsation or bruit was elicited through the upper lid, and no mass could be palpated in the orbit. The pupil was round and reacted well to light and in accommodation. The right palpebral fissure measured 10 mm. and the left, 9 mm.; there was no lagophthalmos. Muscle balance tests revealed orthophoria for distance and slight exophoria for near objects. The near point of convergence was 100 mm.

Hertel's exophthalmometer registered 23 mm. for the right eye and 17 mm. for the left at 110 mm.

The intra-ocular tension (with the Schiötz tonometer) was 21 mm. of mercury in each eye. Examination of the right fundus revealed definite papilledema, more

Fig. 1.—Photograph of the fundus showing the marked papilledema with the peculiar lines in the retina.

marked on the nasal side, where the elevation of the disk was about 4 diopters (fig. 1). The borders of the disk were blurred and all the vessels dilated. There were peculiar lines in the retina which seemed to radiate from the upper pole of the disk. Whether these lines were folds in the retina or dilated choroidal vessels was difficult to determine. The appearance was as though a mass were pushing the optic disk and adjacent portion of the retina forward on the nasal side. The homatropine acceptance test gave a refraction of +4.00 sph. $\frown$ +1.00 cyl., axis 120°, with which correction the vision equaled 20/20. The left eye was normal in every respect. The vision was 20/20 with —1.25 cyl., axis 165°.

The general physical examination revealed nothing significant. The patient was a robust, well nourished woman; the heart and lungs were in good condition.

There was one small, flat, pigmented mole on the back below the right scapula. The differential blood count and the blood chemistry were within normal limits. The Wassermann and Kahn reactions of the blood were negative. The basal metabolic rate, taken on two occasions, was —12 and —7 per cent, i. e., within normal limits.

The visual fields studied with the Ferree and Rand perimeter, with an illumination of 7 foot-candles, revealed normal peripheral fields for form and color. A slightly enlarged blindspot and a small paracentral scotoma on the temporal side were found on the neutral gray tangent screen with a 1 mm. test object at a distance of 750 mm. The visual fields tested at regular intervals remained unchanged during the period of observation.

Roentgenograms of the skull, nasal sinuses and optic foramen, taken a few times at the New York Eye and Ear Infirmary and at the Institute of Ophthalmology, showed that these structures were normal. Dr. Dixon's report was as follows: "There is a slight increase in the density of the shadow of the contents of the right orbit. The optic foramen is circular in shape and symmetrical, measuring approximately 4.6 mm. in diameter. All the paranasal sinuses appear to be clear."

Course.—Since there were straightforward exophthalmos, good mobility of the eyeball, resistance to backward pressure, papilledema and a change from myopic to hyperopic refraction, which was suggestive of shortening of the axis of the eyeball, a neoplasm of the muscle funnel was suspected. The patient was presented at the meeting of the Section of Ophthalmology of the New York Academy of Medicine in December 1932 with a provisional diagnosis of tumor of the muscle cone or the optic nerve. The consensus was that an orbital tumor was present and that surgical intervention should be undertaken within a short period.

The patient, however, refused operation. The exophthalmos progressed slowly, and in February 1933 the exophthalmometric reading for the right eye was 24 mm. Roentgen therapy was decided on. The patient received a course of roentgen treatment at the Memorial Hospital under the supervision of Dr. Hayes Martin. Divided doses of roentgen rays were given with a small cone, the beam being directed through the temple at the retrobulbar region. The treatment was given with a 200 kilovolt machine through a 0.5 mm. copper filter. The patient received 300 x-r (roentgens) daily for six days. No favorable results were obtained. The vision remained 20/30 with a + 3.00 sph. ⊃ + 0.75 cyl., axis 170°. Limitation of motion of the eyeball upward and outward was observed with a slight displacement downward. The patient stated that during emotion and the menstrual period the protrusion of the eyeball was more noticeable. The lacrimal gland was enlarged and could be palpated. An operation was offered, but the patient again declined it. Another course of roentgen treatment similar to the first was suggested by Dr. Martin and given in May 1933.

In October all the signs and symptoms were more pronounced. The exophthalmos in the right eye measured 26 mm. Limitation of motion of the eyeball upward and outward was more marked (fig. 2). The fundus presented more pronounced changes. There was a small hemorrhage in the center of the disk. The swelling of the disk was 5 diopters on the nasal side; the peculiar lines or folds of the retina were increased in number. After induction cycloplegia with homatropine refraction was again done; retinoscopic examination revealed refraction of + 5.00 sph. ⊃ + 1.00 cyl., axis 135°. Vision with this correction was 20/30 but indistinct. An operation was urged, to which the patient finally gave her consent.

The operation was performed on Nov. 23, 1933, by Dr. John Wheeler at the Institute of Ophthalmology with the patient under avertin anesthesia.

Operative Procedure.—After routine preparation of the right eye a V-shaped incision was made through the skin at the outer canthus, extending about 3 cm. in the upper lid and about 1.5 cm. in the lower. The lateral canthal ligament and the tarsal orbital fascia were separated, and the orbit was entered. The lacrimal gland was located and carried forward, and immediately behind it a firm, encapsulated tumor was encountered. This was fairly easily removed from the periosteum of the lateral orbital wall, but it was more firmly adherent to the lateral rectus muscle, which was probably damaged in the separation. The tumor was removed intact and was observed to be an ovoid mass from 2 to 3 cm. in diameter. The cutaneous incision was closed with interrupted silk sutures, and an intramarginal suture was placed. Pressure dressing was applied.

Fig. 2.—Appearance of the patient before the operation, demonstrating the limitation of motion of the eyeball upward.

Postoperative Course.—Postoperative recovery was rapid and uneventful. In two weeks after the operation the patient noticed that there were no tears from the right eye when she cried; she also saw double when looking up and out.

On December 15 the exophthalmometric reading was 17 mm. in each eye at 110. The fissures measured as follows: on looking front, 5 mm. for the right eye and 9 mm. for the left; on looking up, 8 mm. for the right eye and 12 mm. for the left; on looking down, 3 mm. for the right eye and 5 mm. for the left.

Muscle Balance: Hyperphoria in the right eye measured 4 degrees; exophoria for near points, 18 degrees. The near point of convergence was 110 mm. The vision of the right eye was 20/30. Papilledema was receding.

Two months later the dryness of the eye and diplopia had disappeared. In three months the exophthalmometric readings were 16 mm. in the right eye and 17 mm. in the left eye. The scar at the site of incision was scarcely noticeable. Motion of the eyeball in all directions and convergence were good. Ophthalmoscopic examination showed that swelling of the optic disk and wrinkling of the

retina were still present. The vision of the right eye with + 3.00 sph. ⊃ + 1.0 cyl., axis 120°, was 20/20.

Nine months after the operation the eye was slightly enophthalmic (fig. 3). The exophthalmometer registered 16 mm. in the right eye and 17 mm. in the left. The ophthalmoscope still revealed moderate swelling of the disk with wrinkling of the retina.

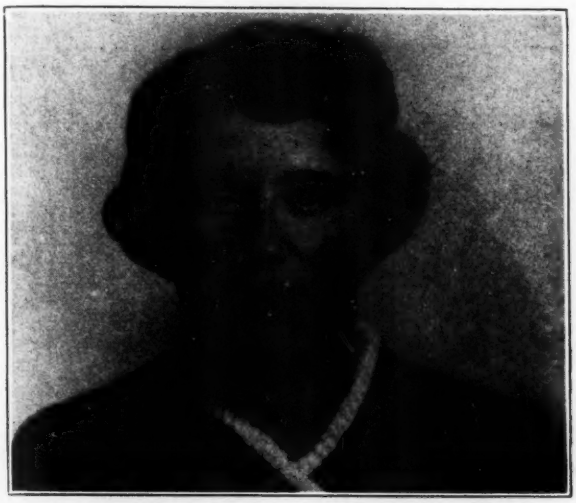

Fig. 3.—Appearance of the patient nine months after the operation.

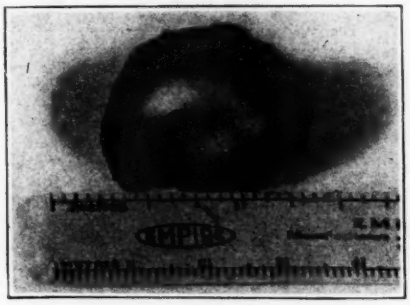

Fig. 4.—Gross appearance of the tumor.

Pathologic Examination.—Macroscopically the tumor measured 29 by 20 by 20 mm. (fig. 4). This mass, which had been cleanly removed, was ovoid, well encapsulated and rather firm; the cut surface was smooth and brownish gray.

Microscopic sections of the tumor presented a cellular tissue (fig. 5) arranged in interlacing bundles. The cell bodies were not clearly outlined in the sections stained with hematoxylin and eosin. With Masson's trichrome stain they were seen to be spindle-shaped. In several places areas of looser tissue were seen between the heavy bundles, and there the cells showed lateral processes and assumed at times a stellate appearance with thin fibrils arising from the processes

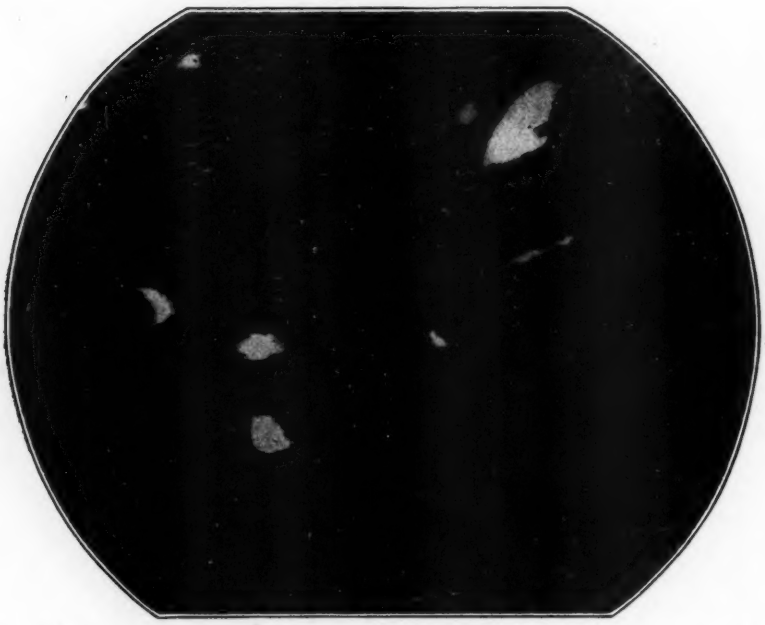

Fig. 5.—Photomicrograph showing fibroblastic tissue consisting of intertwining bundles; Leitz, eyepiece 10, objective 3.

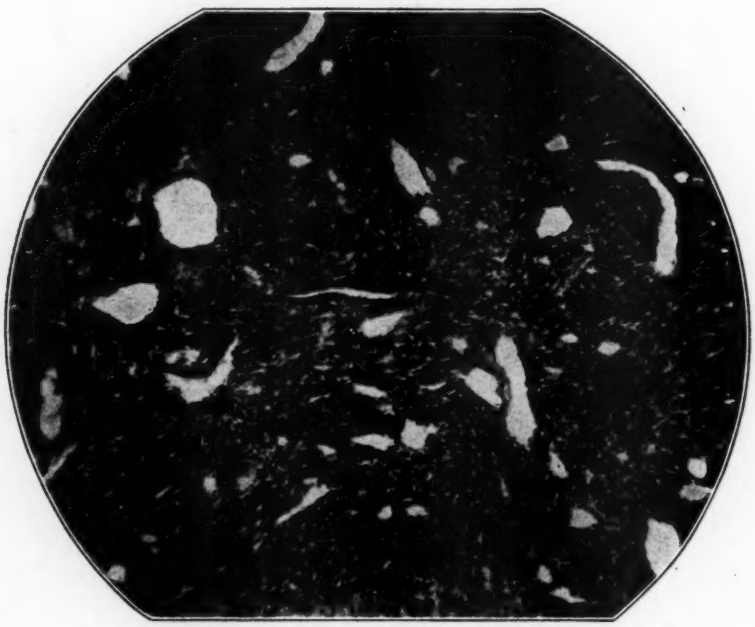

Fig. 6.—Photomicrograph of a vascular area showing numerous wide capillary spaces; Leitz, eyepiece 10, objective 3.

and traversing the cell; the ground tissue, however, did not present the appearance of myxomatous degeneration, so that the cells could be regarded as young connective tissue cells. The nuclei of the tumor cells in all parts of the growth were fusiform or elongated, and in the wavy parts of the bundles they also appeared wavy at times. They were not hyperchromatic; no definite palisading of nuclei was seen, and no mitotic figures were observed. Collagenous fibers, especially well seen in sections treated with the trichrome stain, were present within the bundles between the tumor cells. Occasional collagenous fibrils traversed also the areas of loose tissue, but the majority of the fibrils of these areas took the cellular stain.

The tumor contained a large number of blood vessels (fig. 6), most of which were wide, gaping capillaries with a wall consisting of endothelial cells and several strands of collagenous fibers. In one corner of the section heavy bundles of collagenous fibers, almost without cells, ran between the blood vessels. Numerous narrow capillaries, with a diameter equal to that of a single red blood cell, and a few completely collapsed capillaries were present in all parts of the tumor, but the bundles of tumor tissue did not seem to aline themselves in a definite relation to the blood vessels.

In sections stained with the Laidlow stain for reticulin a large amount of this substance was seen in bundles of heavy, interlacing fibers. The fibrous capsule of the tumor, which was not complete in the sections examined, consisted of collagenous connective tissue with a small portion of fat tissue attached in one place. One of the arteries in the capsule showed evidence of atheromatosis; similar changes were present in one of the arteries within the tumor.

COMMENT

The tumor consisted of well vascularized, cellular connective tissue which in several areas was young. Although the amount of collagenous fibers was considerable, it was not predominant as it is in the ordinary fibroma arising from the fibrous tissue of the orbit or periosteum. The capillaries were so numerous in all parts of the tumor that a few pathologists diagnosed it as hemangioma.

Dr. Verhoeff's opinion on the tumor was as follows: "My diagnosis is hemangioma. If the sections are studied carefully it can be seen that atypical blood vessels are forming in many places in the tumor. In my opinion there are a great many tumors diagnosed as fibromas and sarcomas that are really angiomas. . . ." Dr. Reese thought the growth to be a hemangioma of the scirrhous type. Since it was essentially fibroblastic in nature, the diagnosis of hemangioma was disputed by other pathologists, who classified the growth as neurinoma (Stout and Laidlow), fibroma of the muscle tendon or sclerotic angioma (Stewart). Dr. James Ewing (in a personal communication) suggested the diagnosis of neurofibroma.

No nerve fibrils were noted within the neoplasm, and no nerves were attached to it. The nuclei showed no definite tendency to palisading, which is typical of neurinoma. Since the weight of opinion leaned

toward the diagnosis of perineurial fibroblastoma and since Orzechowski [1] expressed the opinion that a number of neurinomas have no connection with nerves and that the nerve fibrils may be missing occasionally, I was inclined to accept the diagnosis of solitary neurinoma of the orbit as the most justifiable.

A search of the literature for reports of orbital tumors revealed descriptions of few growths similar to that in my case as regards pathologic structure. Orbital tumors in general are rare. At the New York Eye and Ear Infirmary in 1930, of a total number of 35,869 patients, only 9 were recorded as having orbital tumors. At the Royal London Ophthalmic Hospital in 1930, among 52,372 patients only 1 was admitted to the hospital with the diagnosis of orbital neoplasm (Samuels [2]).

Neurofibroma of the orbit is rare. Tertsch [3] stated that "a solitary neuroma is a very rare tumor and its localization in the orbit appears as a curiosity." Birch-Hirschfeld [4] indicated that prior to 1930 only 20 cases of neurofibroma were reported in the literature. Plexiform neurofibroma of the orbit, according to him, is secondary to a growth on the upper lid or temple; it is differentiated by its congenital origin and by the presence of peculiar vermiform cords which can be palpated and which Lagrange [5] compared to "poorly cooked macaroni." These cords are composed of connective tissue rich in nuclei, the origin being mostly from the orbital nerves. Snell and Treacher Collins [6] and Lagrange expressed the belief that a plexiform neurofibroma is formed through the exuberant growth of the fibrous perineurium and endoneurium. The plexiform neurofibroma described by Parsons [7] (Rockleiffe's case) consisted of convoluted and coiled nerves of various sizes, surrounded by dense fibrous tissue. These nerve cords were composed of enormously hypertrophied sheaths with proliferation of the endoneurium and perineurium, the first structure being most affected. No nodules were found in other parts of the body of my patient, and

1. Orzechowski, K.: Neurinoma, in Jadassohn, J.: Handbuch der Haut und Geschlechtskrankheiten, Berlin, Julius Springer, 1932, vol. 12, pp. 2 and 163.

2. Samuels, B.: Some Notes on Orbital Tumors, Arch. Ophth. **7**:868 (June) 1932.

3. Tertsch, R.: Ein Neurinom der Orbita, Arch. f. Ophth. **55**:121, 1903.

4. Birch-Hirschfeld, A., in Schieck, F., and Brüchner, A.: Kurzes Handbuch des Ophthalmalgie, Berlin, Julius Springer, 1930, vol. 3, p. 78.

5. Lagrange, F.: Traité des tumeurs de l'oeil, Paris, G. Steinheil, 1904.

6. Snell, S., and Collins, Treacher: Plexiform Neuroma of the Temple, Orbit, Eyelids and Eyeball, Ophth. Rev. **22**:269, 1903.

7. Parsons, J.: The Pathology of the Eye, London, J. & A. Churchill, 1908, vol. 2, p. 732.

no cords could be palpated; i. e., there was no manifestation of Recklinghausen's systemic disease.

A neurinoma, as described by Orzechowski,[1] is composed of two basic tissues: a fibrillar tissue, rich in nuclei, and a reticular tissue, poor in nuclei. Usually one of these tissues is predominant. Palisading, or the formation of thick rows of oblong nuclei giving the effect of the striping of a tiger, is characteristic. The supply of blood vessels is frequently abundant, and the vessels are of small caliber. A number of neurinomas have been reported in which no connection with nerves could be established.

Tertsch [3] in 1903 reported a case of neurinoma of the orbit which he believed to be the first on record. At one pole of the tumor a nerve 1 mm. thick was seen, which disappeared within the tumor. The tumor consisted of a central, darkly stained tissue, poor in nuclei, and a peripheral, lighter-stained tissue, rich in nuclei. He considered the origin of this simple neuroma to be the cells of Schwann's membrane. Marchetti [8] described the second case of neurofibroma in the literature. Parker [9] reported the third case of neurofibroma in 1907; there was slowly developing exophthalmos for a period of twelve years. The tumor was removed by Krönlein's operation. Microscopic examination revealed that it consisted of fibrous connective tissue with nerve fibrils running through the center. In some parts they were collected into a nerve trunk, but in the greater part they were separated by connective tissue. Valude [10] described an encapsulated tumor of the superior orbital margin of the left eye which had been growing for twelve years. The histologic examination showed an abnormal proliferation of connective tissue from the frontal and supra-orbital nerves. The interesting feature of his case was a zone of anesthesia which developed in the frontal and parietal regions, i. e., in the areas supplied by the nerves.

Accardi [11] reported a case of slowly developing exophthalmos in a man aged 20. The microscopic examination revealed a cellular tumor with abundant protoplasm, large, darkly stained nuclei and a number of nerve fibers running through the tumor. Pertzeva [12] and Cohen [13] reported cases of true neurinoma, "a tumor classed by the older patholo-

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8. Marchetti, O.: Falso neuroma del nervo sotto-orbitario, Ann. di ottal. e clin. ocul. **33**:29, 1904.

9. Parker, W.: Neurofibroma of the Orbit: Krönlein Operation, J. A. M. A. **49**:17 (July 6) 1907.

10. Valude, M.: Neurofibrome de l'orbite développé aux depend du nerf frontal, Ann. d'ocul. **141**:441, 1909.

11. Accardi, V.: Nevrofibroma dell' orbita, Boll. d'ocul. **6**:111, 1927.

12. Pertzeva, V.: Neurinoma of the Orbit, Moscow, 1926, p. 257.

13. Cohen, M.: Report of a Case of Orbital Neurinoma, Arch. Ophth. **54**:426 (Sept.) 1925.

gists as neurofibroma" (Cohen). Neurinoma is one of the groups of true neuromas of the immature type of Verocay, which is characterized by the presence of a basic cellular tissue staining yellow by Van Gieson's method, the nuclei of which form ribbon-like strands and which give in oblique sections the "barrel-shaped figures" of Verocay (Pertzeva). In MacMillan and Cone's [14] case the microscopic sections showed fibroblastic tissue with medullated and nonmedullated nerve fibers scattered through it. Laidlow's stain demonstrated the palisading of the nuclei with collagen fibers between them.

The only case in which the histologic picture showed a close resemblance to that in my case was a case of an orbital tumor of the type of a perineural fibroblastoma reported by Stieren.[15] The patient had exophthalmos, papilledema and hyperopia of 10 diopters in the right eye. No nerve tissue was demonstrated on histologic examination. There was a moderate amount of blood vessels. The tumor consisted of oval nuclei and bundles of intertwining collagenous fibrils in the intercellular spaces. The diagnosis of neurofibroma was made, indicating the source of the tumor despite the absence of nerve tissue.

The clinical course in my case presented a few features worthy of mention. The vision remained little impaired, even though there was marked papilledema with wrinkling of the retina. Clinically the tumor could be considered benign because of the absence of pain and the good motion of the eyeball. Birch-Hirschfeld [16] considered the motility of the eyeball a favorable prognostic sign, for in cases of malignant infiltrative tumor there is early limitation of motion of the eyeball. No bruit or pulsation was elicited, the tumor was not compressible and no other vascular tumors were found on the body. A slight increase of exophthalmos was, however, observed during menstruation and periods of emotional excitability. Birch-Hirschfeld emphasized that the increase in the volume of a tumor during venous stasis, as in bending the head, coughing or crying and during pressure on the jugular vein and during the menstrual period and pregnancy, is a positive sign of vascular tumor. Although the tumor was attached to the external rectus muscle postoperative diplopia when the patient looked up and out was observed only for a few weeks, while Giri [17] reported a case of orbital fibroma in which annoying diplopia, lasting for nine months, required operative intervention.

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14. MacMillan, J., and Cone, W.: Solitary Neurofibroma of the Orbit, Arch. Ophth. **10**:51 (July) 1933.

15. Stieren, E.: Neurofibroma of the Orbit, Am. J. Ophth. **6**:176, 1923.

16. Birch-Hirschfeld, A., in Graefe, A., and Saemisch, T.: Handbuch der gesamten Augenheilkunde, Berlin, Julius Springer, 1930, vol. 9, p. 659.

17. Giri, D.: Fibroma of Orbit, Tr. Internat. Ophth. Cong. **2**:563, 1929; abstr., Arch. Ophth. **4**:274 (Aug.) 1930.

SUMMARY

A case of orbital tumor causing slowly progressing exophthalmos of the right eye of two and one-half years' standing which was successfully operated on is described. The most interesting feature was the debatable pathologic diagnosis based on the atypical histologic structure of the neoplasm. The diagnosis of neurinoma or perineural fibroblastoma was accepted with certain reservations, after the opinions of various pathologists and the reports in the literature had been carefully weighed.

Dr. Algernon B. Reese prepared and studied the slides, and Dr. Vera B. Dolgopol described the microscopic sections of the tumor.

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MEASUREMENT OF SPEED OF ADJUSTMENT OF EYE TO NEAR AND FAR VISION

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One phase of ophthalmologic study which has been only lightly touched on is the measurement of the speed of adjustment of the eye to near and far vision. At the present time there is no means for testing speed of vision in use by the Department of Commerce, the United States Navy or the United States Army in connection with the physical examination of aviators.[1] Owing to the statement by ophthalmologists that such a measure is a necessary adjunct of the physical examination of pilots and that a standard should be set, I have attempted a series of tests to evaluate the necessity for such knowledge.

Ferree and Rand,[2] of the Wilmer Institute of the Johns Hopkins Hospital, have developed an apparatus called the tachistoscope. I have been able to make a few preliminary tests with this apparatus. The tests were too few for the formation of a definite conclusion as to the standard of speed, but they have confirmed my opinion that speed of vision plays an important part in the physical ability of the aviator and that an intensive study along these lines should be instituted with a view to establishing such a standard or to showing that it is of only relative importance in the light of the knowledge which I have already gained in our examinations of the eye.

EXPERIMENTAL PROCEDURE

The tachistoscope is an apparatus mechanically adjusted so that the procedure in examination is as follows:

There are three test objects, the letter E being separately rotatable in eight positions, which are adjusted on the same vertical line as that of the eyes. The two near objects are far enough apart that the far object can be easily discerned between them. The three objects are illuminated by 5 foot-candles of light, checked with the Macbeth illuminometer. An adjustable head-rest is used to place

1. Aviation Physical Examination, United States Navy Standard, 1927, in Manual of the Medical Department, United States Navy, 1927. United States Department of Commerce: Physical Standards for Airplane Pilots Including Standards for Lighter than Air Pilots, revised July 1, 1930, Washington, D. C., United States Government Printing Office, 1930. United States Department of War, Army Regulation, Medical Department: Standard for Physical Examination for Flying, Washington, D. C., United States Government Printing Office, 1931.

2. (*a*) Ferree, C. E., and Rand, G.: Intensity of Light and Speed of Vision, J. Exper. Psychol., vol. 12, October 1929. (*b*) The Inertia of Adjustment of the Eye for Clear Seeing at Different Distances, Tr. Am. Ophth. Soc. **16**:142, 1918.

the observer's head so that he can fixate on the first E at the left at a distance of 33 cm., on the far test object at 6 m. and on the second near test object on the right at 33 cm. Thus, with the rotating plates directly in front of the near test objects so timed that the speed can be recorded in degrees, which can be transposed into seconds, the measurement of the speed of adjustment to near vision, near to far and far to near, is accomplished. As an example, an observer is placed before the apparatus, his head in the head-rest, so that his eyes are directly in line with a horizontal slit through which all the test objects can be

Fig. 1.—Tachistoscope as employed in the tests.

seen. The test objects are set at various angles and the rotating time mechanism is ready for movement. The observer is directed to fix his eyes at a marked spot on the rotating apparatus in front of the near E on the left. The time mechanism, adjusted on this preliminary trial for what has been found to be an average speed, is started. The observer attempts to read the three E's, naming them after the completion of the entire revolution of the time mechanism. A number of trials are made to accustom the observer to the apparatus. The test is then continued, the speed being shortened or lengthened, until a conclusion is reached as to the speed of vision of the observer.

RESULTS

In table 1 are shown the time values in seconds for adjustment from near to far vision and from far to near vision and for the complete adjustment as recorded by the tachistoscope, and the data are included which are considered of value in an attempt to evaluate the worth of the apparatus and the necessity for speed of vision. Such data include the age of the observer and his hours of flight, years in aviation, visual acuity, phorometer findings, angle of convergence and depth perception.

TABLE 1.—*Results of Measurement of Speed of Adjustment to Near and Far Vision and of Other Ocular Tests on Aviators, Aged from 30 to 38*

Number	Observer	Age	Hours of Flight	Years in Aviation	Speed of Adjustment, Time Values, Sec.				Visual Acuity	Esophoria at 6 M., P. D.	Exophoria at 6 M., P. D.	Esophoria at 33 Cm., P. D.	Exophoria at 33 Cm., P. D.	Hypophoria, P. D.	P. D. (Prism)	Accommodation	Angle of Convergence	Depth Perception
					Near Vision	Near to Far Vision	Far to Near Vision	Complete										
1	F. R. S.	30	1,000	5	0.027	0.603	0.493	1.125	20/15	4	..	..	5	...	..	9.0	59	12
2	A. C. D.	31	1,500	13	0.027	0.738	0.450	1.215	20/20 20/20+4	4	..	3	..	...	4	8.0	65	10
3	W. M. B.	30	1,500	7½	0.045	0.639	0.531	1.215	20/15	..	3	..	2	...	..	10.5	65	5
4	G. E. L.	32	2,500	6	0.036	0.438	0.486	1.260	20/20	..	..	..	4	...	4	8.5	65	7
5	E. S. W.	32	1,600	7	0.027	0.738	0.450	1.215	20/20	2	..	..	3	0.2	..	8.0 7.5	64	5
6	E. O. S.	33	1,487	5	0.036	0.639	0.585	1.260	20/20+7 20/20+5	1.5	..	..	10	...	4	8.0	58	10
7	D. K.	33	2,700	11	0.036	0.549	1.035	1.620	20/20	..	1	..	2	...	..	6.5	54	10
8	N. D. M.	34	1,800	10	0.027	0.603	0.585	1.215	20/15	2	..	8	..	...	6	8.5	58	7
9	G. B. S.	34	1,800	10	0.027	0.603	0.630	1.260	20/20	..	6	..	4	...	..	8.5	57	8
10	B. H. J.	35	2,806	8	0.027	0.648	0.630	1.350	20/20	..	1	..	16	...	..	8.0	54	15
11	A. F. J.	35	1,650	10	0.027	0.603	0.630	1.260	20/15	3	..	..	6	...	7	8.0	56	14
12	A. E. B.	36	1,400	8	0.027	0.963	0.360	1.260	20/20	..	1	..	9	...	6	7.0	60	10
13	J. D. L.	38	2,115	11	0.027	0.783	0.540	1.360	20/20	2	..	..	4	...	6	5.5	62	13
14	W. S. C.	38	1,200	7	0.063	0.567	0.405	1.035	20/20	4	1	..	3	...	5	6.0	58	10
15	A. D. R.	38	1,350	9	0.027	0.693	0.590	1.260	20/20	3	..	..	..	0.6	6	6.0	56	12

In later work with observers, more data have been used, such as refractive errors, etc.

In table 2 are shown the results of a series of tests on midshipmen between the ages of 18 and 24 and their visual acuity.

In table 3 the speed of vision of the midshipmen is compared with that of the older aviators, aged from 30 to 38.

Through the courtesy of Ferree and Rand I have been able to add the results of tests on eighteen unselected observers, nonwearers of glasses, aged from 18 to 40 (Ferree and Rand), and on fourteen wearers of glasses, aged from 22 to 44 (ten by Goodall and four by Ferree and Rand).

The data for these observers with those for the fifteen midshipmen and the fifteen aviators furnish an opportunity for a comparative study. In making this study it must be understood that the number of tests is too few for a final determination and that the results are valuable only as furnishing an estimate for future study with the tests on hundreds of subjects as a basis.

For the entire group of sixty-two subjects, with only the time factor considered, the following results were obtained: In the test for changes

TABLE 2.—*Results of Measurement of Speed of Adjustment to Near and Far Vision in Midshipmen, Aged from 18 to 24*

No.	Name	Age	Visual Acuity		Speed of Adjustment, Time Values, Sec.			
			Far	Near	Near Vision	Near to Far Vision	Far to Near Vision	Complete
1	E. W. C.	19	20/15	J1	0.018	0.567	0.450	1.035
2	J. L. J.	20	20/15	J1	0.027	0.648	0.495	1.080
3	A. M.	19	20/15	J1	0.027	0.558	0.540	1.125
4	F. J. H.	18	20/15	J1	0.027	0.603	0.495	1.035
5	W. S. A.	24	20/15	J1	0.027	0.603	0.450	1.080
6	F. W. H.	20	20/15	J1	0.027	0.738	0.540	1.305
7	E. R. C.	18	20/15	J1	0.027	0.738	0.585	1.350
8	J. C. K.	19	20/15	J1	0.027	0.693	0.495	1.215
9	L. F. D.	18	20/15	J1	0.027	0.603	0.450	1.080
10	D. A. B.	19	20/15	J1	0.027	0.558	0.450	1.035
11	C. J. J.	20	20/15	J1	0.027	0.558	0.495	1.080
12	K. L. D.	20	20/15	J1	0.027	0.603	0.405	1.035
13	N. D. M.	19	20/15	J1	0.027	0.558	0.495	1.080
14	C. H. C.	18	20/15	J1	0.027	0.603	0.495	1.125
15	A. H. B.	21	20/15	J1	0.027	0.693	0.450	1.170

TABLE 3.—*Comparative Results of Tests of Speed of Vision on Fifteen Midshipmen and Fifteen Aviators*

Group	No.	Age	Average Time Values, Sec.			
			Near Vision	Near to Far Vision	Far to Near Vision	Complete
Midshipmen	15	18 to 24	0.0264	0.6216	0.486	1.122
Aviators	15	30 to 38	0.324	0.6738	0.5568	1.2576
			Difference in Time Values in Two, Sec.			
Average			0.006	0.0522	0.0508	0.1356

from near to far vision and the return to near vision, of the fifteen observers who completed the test between 0.95 and 1.15 seconds, ten were midshipmen and three, aviators. In the group completing the test between 1.15 and 1.35 seconds, ten were aviators and four, midshipmen. In the other three groups with the longer time element were found only one midshipman and three aviators. It was considered that the midshipmen and aviators are picked men physically and that they should demonstrate a more rapid measurement of speed than those in the unselected groups. This they have definitely done. The unselected subjects (nonwearers of glasses) predominated in the group completing

the test between 1.35 and 1.55 seconds, while the wearers of glasses were found mostly in the group finishing between 1.55 and 1.75 seconds.

It is emphasized that midshipmen predominated in the group completing the test between 0.95 and 1.15 seconds. They were between the ages of 18 and 24. The aviators were in the group finishing between 1.15 and 1.35 seconds and were between the ages of 30 and 38.

In figures 2 and 3, the speed element is definitely demonstrated in the two main groups, i. e., the midshipmen and aviators and the unselected subjects.

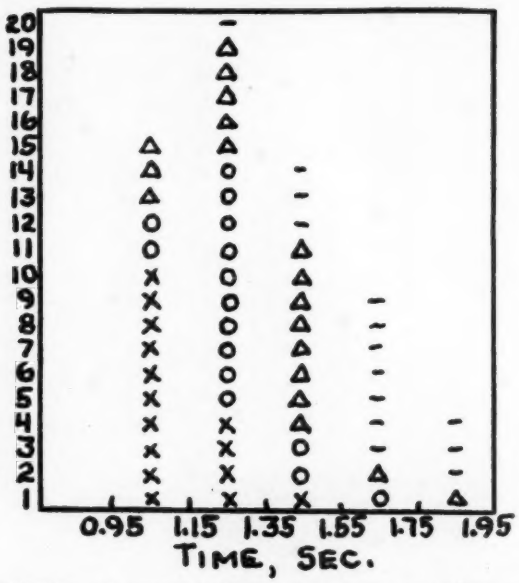

Fig. 2.—Distribution of groups of the observers according to speed of vision in tests with the tachistoscope. The crosses represent the midshipmen, aged from 18 to 24; the circles, the aviators, aged from 30 to 38; the triangles, the unselected group of subjects, not wearing glasses, aged from 18 to 44, and the dashes, that for the unselected subjects, wearing glasses, aged from 22 to 44.

There are a number of comparative studies which might be made, such as between wearers of glasses and nonwearers of glasses, midshipmen and aviators and so on, but this is not considered of merit until results of more tests can be collected. A study of various phases of the index, such as "near to far vision" as compared with "far to near vision" will be of value, as well as a comparative study of speed under ocular fatigue and the normal speed.

There are two types of tests for speed of vision, i. e., a static and a dynamic test. In the static test the eyes fixate and accommodate for a selected distance on the test object. This test is considered suitable

only for the testing of the speed of reaction of the sensorium. It would not test eyes with inferior oculomotor facility or even those with partial motor paralysis.

In the dynamic test for speed of vision, the eyes are required to shift from a near object on the left to a far object in the median plane and then to return to a near object on the right. Thus, the first change involves, besides the discrimination of the object, the relaxation of the muscles of accommodation and divergence and a lateral movement to the right; the second change involves accommodation for near vision and a converging and lateral movement still farther to the right, constituting three factors which contribute to the final result—speed of

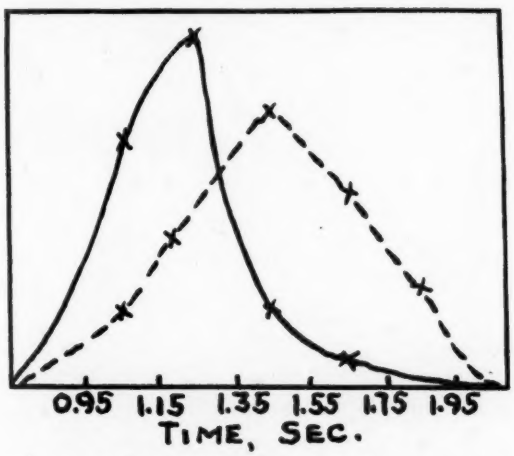

Fig. 3.—Curves representing distribution of groups of observers according to speed of vision in tests with the tachistoscope, expressed in seconds. The solid line represents the values for midshipmen and aviators; the broken line, those for the unselected subjects.

reaction of the sensorium, speed of accommodation for near and far vision and speed of coordinated eye movement.

In youth the speed of reaction of the sensorium and that of accommodation are so rapid that it is probable that the value of the tachistoscope will be found only in detecting the abnormal eye, but as the factor of age creeps in the speed of accommodation decreases, and thus it is possible that a determination of the age limit for flying may be established.

Only multiple examinations, including those for aviators of various ages and with different refractive errors, muscular imbalances, etc., will show the value of the tachistoscope or a similar mechanism and furnish a standard of speed, either for a person of a given age or for the vision necessary for piloting certain types of planes.

Ferree and Rand in 1918 [2b] completed a series of tests on the inertia in the adjustment of the eye for clear seeing at different distances. Their purpose in making the tests was to ascertain whether eyes rated as normal by clinical tests could not be more finely graded as to their working efficiency or fitness for special purposes. In 1929 [2a] they completed a series of tests for intensity of light and speed of vision, noting the greater effect produced by the intensity of light.

Teft and Stark [3] in 1922 stated that while this method of testing speed of accommodation with the tachistoscope is satisfactory in determining the actual speed it is also a test, to a certain extent, of immediate memory. This objection I have found to be true. But this can be overcome to a certain degree by practice trials, although some subjects find it difficult to adjust themselves to this particular test.

Goodall [4] found that uncorrected astigmatic errors and conditions of muscle imbalance tend to retard the speed of adjustment to a marked degree; he considered that the tachistoscope is useful not only in determining the speed of adjustment, particularly that of accommodation, but in detecting defects of vision which are not readily revealed by the Snellen test letters. Being convinced that accommodation enters in many ways into the act of piloting a ship, especially in landings and in pursuit work, in which rapid change of focus from far to near and from near to far objects is required, he expressed the belief that the measure of the time element is necessary.

Richmond and Ebert [5] in 1933 performed a series of tests for speed of visual perception in order to arrive at a conclusion as to a reasonable time necessary to recognize letters and colors. They tried three methods: flash-letter tests, and tests with the projection lantern and with camera-box shutters. They concluded that a time factor should be included in the examinations for visual acuity; that 0.5 second is a good standard unit for each eye; that visual speed is decidedly greater by daylight than by artificial light; that a few candidates with slow color perception apparently compensated with rapid form perception; that color perception is not diminished as rapidly as form perception by shortening the period of observation, and that speed of perception when both eyes are used is twice that of monocular vision.

Berens and Smith,[6] in regard to ophthalmologic standards for aviation, stated that rapid reaction time is most important for the military

3. Teft, L. E., and Stark, E. K.: Speed of Accommodation as a Practicable Test for a Flier, Am. J. Ophth. **5**:339, 1922.

4. Goodall, E. B.: The Speed of Accommodation, Air Medical Service, 1920, vol. 6, p. 70.

5. Richmond, P., and Ebert, E. C.: Speed of Visual Perception, U. S. Nav. M. Bull. **31**:150, 1933.

6. Berens, Conrad, and Smith, Henry Templeton: Present Ophthalmologic Standard for Commercial Aviation in the United States, Tr. Am. Acad. Ophth., 1931, p. 333.

and the public aviator and that a means should be established for its recognition.

The Bureau of Medicine and Surgery of the United States Navy [7] in November 1933 made a change in the physical qualifications for diving and submarine duty in that a standard of four seconds for the reading of all letters on the 20 foot line was adopted.

Ferree and Rand, Goodall, Teft and Stark completed their tests with the original tachistoscope, developed by Ferree and Rand in 1917 and 1918 and considerably improved by them in 1932 and 1933. This improved tachistoscope was used in the present tests.

A further study of 363 tests with the tachistoscope has just been completed at the Naval Air Station at Hampton Roads, Va. Testing under conditions of ocular fatigue is now being accomplished at Pensacola, Fla.

SUMMARY

Owing to the rapid mechanical advancement of the airplane in a short space of time, as evinced in tremendous speed and rapid maneuverability, and the necessity, particularly in military aeronautics, of aerial gymnastics, diving, as in dive bombing; close formation flying, etc., it seems that speed of vision is an essential part of the physical make-up of the aviator and that a knowledge of such vision with ability to judge the limits should be a portion of the flight surgeon's information on each pilot.

Such work as has been done by Ferree and Rand, Goodall, Teft and Stark, Richmond and Ebert and by the tests here recorded leads me to believe that a more intimate knowledge of speed of vision is essential in order that a flight surgeon may keep abreast of the development of the airplane. This article was written with the hope that it may stimulate interest, particularly on the part of the flight surgeon and the physician trained in ophthalmologic work.

CONCLUSIONS

Speed of vision in aviation is essential, and measurement of this speed can be made.

A standard of measurement of speed of vision can be established if sufficient tests are made on men of various ages.

Such a standard, if established, should be incorporated in the visual requirements for aviators.

Such tests disclose the pathologic eye.

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7. Bureau of Medicine and Surgery Circular Letter 572, Nov. 10, 1933, change no. 19, Manual of the Medical Department, United States Navy, 1927.

ENDOPHTHALMITIS PHACO-ANAPHYLACTICA

A CLINICAL STUDY

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My purpose in this paper is to report the results of an investigation on the subject of endophthalmitis phaco-anaphylactica. The clinical material used for this study consisted of 700 unselected patients with cataract who were admitted to the Wills Hospital during 1932.

THE DETERMINATION OF HYPERSENSITIVITY TO LENS PROTEIN

Each of the 700 patients with cataract was first given a cutaneous test, and the test was repeated on subsequent admissions. Further repetitions of the test were made during the stay of some of the patients in the hospital whenever the situation demanded it. A total of 1,038 tests were made.

Each cutaneous test consisted of a series of three injections given intradermally in the forearm after the area to be used had been cleansed with alcohol and allowed to dry. The solutions which were used were sent to me by Dr. Earl L. Burky of the Wilmer Institute and were prepared according to the published reports of Burky and Woods.[1]

The first injection consisted of 0.1 cc. of a 1 per cent solution of lens extract. The other two injections were controls: One consisted of 0.1 cc. of an 0.85 per cent solution of sodium chloride containing 0.5 per cent cresol, U.S.P., and the other, of 0.1 cc. of beef serum in the dilution of 1:1,000 containing 0.5 per cent cresol, U.S.P., and sterilized by Berkefeld filtration.

Main Types of Cutaneous Reactions Encountered.—Five patients showed immediate cutaneous reactions to the injections. A reaction appeared within five minutes and consisted of rapidly developing erythema with the formation of a wheal and pseudopodia. In these patients the reaction occurred usually at the site of each of the three injections but was considerably more pronounced where the lens extract and the serum had been injected. It was transitory and disappeared in a few hours. This is the type of reaction seen in cases of food and pollen allergy and was not considered to be positive so far as the investigation reported here was concerned.

This work was aided by a grant from the Wills Hospital.

Read before the Washington Ophthalmological Club, May 10, 1934.

Condensed from a thesis submitted to the faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Master of Medical Sciences.

1. Burky, Earl L., and Woods, Alan C.: Lens Extract: Its Preparation and Clinical Use, Arch. Ophth. **6**:548 (Oct.) 1931.

The delayed or "tuberculin" type of reaction, which usually appeared after several hours and reached its peak in twenty-four hours or later, was by far the most frequent type of reaction encountered and is the kind considered to be associated with endophthalmitis phaco-anaphylactica. All such reactions in which the wheal was more than 0.5 cm. in diameter were given recognition in the readings, but, as will be pointed out later, only the more marked reactions should be rated as being definitely positive. Dr. Earl L. Burky in a personal communication suggested that only those wheals with a diameter of more than 1.5 cm. should be considered as indicative of a positive reaction. He stated that reactions up to this degree occur in persons without disease of the lens but at the time of writing he was unable to explain why they occur. I wish to concur in this opinion and to add that only those wheals which measure more than 1.5 cm. in diameter and are definite in outline and in the depth of the erythema twenty-four hours or more after injection should be considered to be evidence of a positive reaction and to be of interest when prophylactic or therapeutic measures in the way of desensitization are contemplated.

The reactions were graded as follows:

No.	Diameter of Wheal, Cm.	Erythema	Outline	Degree
1	0.5 to 1.5	Faint	Indistinct	+ —
2	1.5 to 2.5	Faint	Indistinct	+ + —
3	2.5 to 3.5	Faint	Indistinct	+ + + —
4	0.5 to 1.5	Definite	Distinct	+
5	1.5 to 2.5	Definite	Distinct	+ +
6	2.5 to 3.5	Definite	Distinct	+ + +
7	3.5 or more	Definite	Distinct	+ + + +

RESULTS OF TESTS

Of the 700 patients tested, 582 (83.1 per cent) showed no cutaneous reaction and 118 (16.9 per cent) showed reactions of from + — to ++++. On the other hand, only 38 patients (5.4 per cent) showed reactions of ++ or more. It was among patients in the latter group that the few cases of undoubted endophthalmitis phaco-anaphylactica were found, and they will be spoken of more specifically later. Of 536 patients tested before the capsule of the lens of one or both eyes had been opened, 447 (83.4 per cent) showed no cutaneous reaction, while 89 (16.6 per cent) showed some degree of reaction. Of the 164 patients who were tested after the capsule of the lens of one or both eyes had been opened, 135 (82.3 per cent) showed no cutaneous reaction and 29 (17.7 per cent) showed some degree of reaction. Though these figures seem to indicate that whether or not the capsule has been previously opened makes little difference in the number of cutaneous reactions obtained, it was noted that all the markedly positive reactions were obtained only after there had been an opportunity for absorption of free lens material from the anterior chamber.

Relation of Postoperative Ocular Reactions to Cutaneous Reactions.—Fifty-three patients showed excessive postoperative ocular reactions which could not be accounted for by any accident at the time of operation, postoperative complication, etc. Of these 53 patients 31 showed no cutaneous reactions and 22 showed cutaneous reactions of some degree. Of the 31 patients with no cutaneous reaction only 4, or 12.9 per cent, showed severe postoperative ocular reactions, while 11, or 50 per cent, of the 22 patients showing cutaneous reactions had postoperative ocular reactions of severe degree.

Another interesting point is brought out by the following comparison. Of the 118 patients with cutaneous reactions of some degree, 59, or 50 per cent, had a normal postoperative course, while of the 38 patients with cutaneous reactions of ++ or more only 17, or 44.8 per cent, had an uneventful recovery.

Also, 32, or 23.7 per cent, of the 118 patients showing cutaneous reactions of some degree had excessive postoperative ocular reactions for which no specific reason could be found, while 14, or 36.9 per cent, of the 38 patients showing cutaneous reactions of ++ or greater had such unaccountable ocular reactions.

It was interesting to note, furthermore, that each of the 5 patients who gave +++ or ++++ cutaneous reactions had a severe postoperative reaction and, incidentally, each of these 5 patients was not seen until long after the capsule of the lens in at least one eye had been opened and there had been plenty of time for autosensitization to develop. This by no means held true for those patients showing milder cutaneous reactions, many of them having perfectly uneventful recoveries. This leads me to the conclusion that severe postoperative ocular inflammation of the anaphylactic type needs to be feared only when the patient has demonstrated marked hypersensitivity to lens protein.

Changes in the Cutaneous Reaction Following Opening of the Lens Capsule.—Twenty-six patients showed no cutaneous reaction to lens protein when first tested and showed reactions of some degree when tested later. These reactions varied from +— to ++. Thirteen of these patients did not have any spilling of the lens material into the eye between the two tests. Each of the remaining 13 patients had an extracapsular extraction following the first test. In 2 cases in which ++ reactions were shown at subsequent injections the technic may have been at fault in the original tests in which there was no reaction. The second tests in these 2 cases were made soon after the first, and the reaction remained strongly positive at subsequent tests. Such errors in technic might consist in the subcutaneous rather than the intracutaneous injection of the lens material or its injection into a vessel

or in the vicinity of a ruptured vessel with consequent diffusion or dilution of the antigen.

It is significant that all the markedly positive reactions were obtained only after there had been an opportunity for absorption of lens material from the anterior chamber. Unfortunately, none of these patients was tested before this opportunity had presented itself. It is my opinion that marked degrees of autosensitization occur chiefly through the absorption of cortical material that has been spilled into the eye either at operation or as a result of trauma and that a patient who has previously shown no sensitivity to lens protein may thus become sensitized.

Spontaneous Changes in the Cutaneous Reaction.—Thirteen patients who at first showed positive reactions later failed to show a reaction without having been intentionally desensitized. In none of these cases was the reaction to lens material more than + —. As has been pointed out, these discrepancies in the lower grades of reaction may have been due to errors in technic or to some nonspecific factor. There was therefore no indication that a patient who previously reacted positively would spontaneously fail to show a response.

Early Appearance of Cutaneous Reactions.—In cases in which there is a transient food or pollen type of reaction the early appearance of erythema usually indicates marked hypersensitivity. However, it is necessary to observe the cutaneous reaction for a period of days before the true degree of sensitivity can be determined. A few patients who showed moderately positive reactions at the end of forty-eight hours showed no appreciable reactions at the end of twenty-four hours.

CUTANEOUS REACTIONS IN RELATION TO THE CHARACTER OF THE DISEASE OF THE LENS

Mature Senile Cortical Cataract (503 Cases).—Of the patients with this condition, 99 (19.7 per cent) showed cutaneous reactions of some degree. It was in this group of patients that the more strongly positive reactions were noted, not counting those patients in whom the capsule of the lens had been previously opened.

Immature Senile Cortical Cataract (61 cases).—All except 6 (9.5 per cent) of the patients showed no reaction. It is to be noted that the incidence of cutaneous reaction is 10.2 per cent less than that observed in the patients with mature cataract. One of these patients showed a reaction to lens protein of + +, and the others showed reactions of lesser degree.

Incipient Senile Cortical Cataract (8 Cases).—None of the patients showed any reaction except 1 patient (12.5 per cent), who showed a + — reaction to lens protein. This incidence of cutaneous reaction is 7.2 per cent less than that observed in patients with mature cataract.

Noncataractous Lens (22 Cases).—None of the patients showed any reaction. In 1 case a clear, dislocated lens was removed, and in another a clear lens was removed because of a high degree of myopia. The remaining patients had no disease of the lens, and were used as controls.

Complicated Cataract (16 Cases, All of Mature Cataract).—Four (25 per cent) of the patients showed cutaneous reactions to lens protein of + — or less.

Congenital Cataract (22 Cases).—None of the patients showed any reaction. The average age of the patients was 5 years, the extremes being 6 months and 21 years.

Traumatic Cataract (63 Cases).—Only 3 patients (4.8 per cent) showed any cutaneous reactions. Several had injuries of long standing (1 patient had sustained an injury sixteen years previously; he showed no reaction), but the majority were tested soon after the lens had been traumatized.

Nuclear Cataract (11 Cases).—None of the patients showed any reaction except 1 patient (9.1 per cent). This patient was given six tests over a period of five months; two elicited mildly positive (+ — and + + —) reactions, and four, no reaction.

Posterior Polar Cataract (5 Cases).—Three patients showed no reaction, and 2 (40 per cent) showed + + reactions. I am unable to verify the fact that these were cases of true posterior polar cataract and not of posterior subcapsular opacities.

Anterior Polar Cataract (1 Case).—The patient showed a + — reaction to lens protein.

Hypermature Cataract (8 Cases).—None of the patients showed any reaction.

Zonular Cataract (1 Case).—The patient showed no cutaneous reaction.

Cataract Due to Electricity (1 Case).—The patient showed no cutaneous reaction.

Summary.—I believe that certain deductions may safely be made from these figures. If only reactions of + + or more are to be considered truly positive reactions to lens protein, the following statements seem to be well supported:

1. Hypersensitivity to lens protein is acquired and not congenital. It is not too much to suppose that the ability to respond to a lens antigen with resultant hypersensitivity has a background in which the influences of heredity are prominent.

2. Cataractous cortical material forms the principal antigenic factor.

3. Hypersensitivity to lens protein occurs only in patients with disease of the lens. This is essentially in agreement with the statement

made by Dr. Burky in a personal communication: "We feel that normal persons never react and that some intra-ocular condition is necessary to produce a positive reaction."

No relationship was found between diabetes, syphilis or asthmatic and hay fever allergic states and the production of autosensitization to lens protein.

RELATION OF THE AMOUNT OF CORTICAL MATERIAL LEFT IN THE ANTERIOR CHAMBER TO POSTOPERATIVE OCULAR REACTION

In all there were 53 cases in which an unaccounted for postoperative ocular reaction was noted: 38 with moderate and 15 with severe reactions. (For obvious reasons the cases in which there was a postoperative reaction which could be accounted for by some accident or complication are not included in the following figures.) The figures which follow show the distribution of these cases according to the amount of cortical material left in the anterior chamber following operation.

Amount of Residual Cortical Material	Moderate Postoperative Reaction, Number of Cases	Severe Postoperative Reaction, Number of Cases
Little or none	10	2
Moderate amount	15	6
Large amount	13	7
	38	15

These figures substantiate the long recognized fact that a large amount of cortical material left in the eye is often the source of considerable trouble. Twenty-one of the patients in whom a moderate or large amount of cortex was left showed no cutaneous reaction. Apparently the ocular reactions in these cases must be attributed either to a toxic property of cataractous lens matter, as suggested by Gifford and Steinberg,[2] or to a mechanical disturbance due to the presence of an innocuous but foreign substance in the anterior chamber.

In 22 cases in which there was a moderate or large amount of residual cortex some degree of cutaneous reaction was obtained. These patients were regarded as having hypersensitivity to lens protein. Though the two divisions of this group—those showing no reaction and those showing some cutaneous reaction—are numerically about equal, 11 severe postoperative ocular reactions were found in the "hypersensitive" group as against 4 in the "toxic" or "mechanical" group. Also it was noted that of the 15 patients showing severe postoperative ocular reactions, 13 had a moderate or large amount of residual cortex and only 2 had little or none.

2. Gifford, S. R., and Steinberg, A. A.: Allergic and Toxic Properties of Lens Protein, J. A. M. A. **85**:351 (Aug. 1) 1925.

The following statements appear to me to be justified as far as these figures are concerned:

1. When lens material is left in the eye of a nonsensitive patient, it is not as great a source of danger as it is when left in the eye of a sensitive patient.

2. The amount of lens material left in the anterior chamber is in direct ratio, generally speaking, to the degree of the postoperative ocular reaction, whether in a sensitive or in a nonsensitive patient.

3. Lens material left in the eye following operation may have a deleterious action through its toxic, mechanical or anaphylactic properties. The anaphylactic action, when present, is productive of the most severe types of reactions.

A combination of the three modes of action might well be supposed to occur. Such an explanation serves beautifully to account for several severe reactions noted in patients who gave weakly positive cutaneous reactions but who had large amounts of residual cortical material in the anterior chamber following operation.

ILLUSTRATIVE CASES

One of the most interesting cases encountered was that of an exceptionally sensitive person who had suffered from severe endophthalmitis phaco-anaphylactica after each of two extracapsular extractions and after each of two needling operations. He was successfully desensitized, and subsequent iridocapsulotomies which were performed on the two eyes were successful and produced only ordinary reactions. Prior to the iridocapsulotomies there was perception only of light in each eye. The corrected vision three months following the iridocapsulotomies was 6/30 in each eye.

An attempt was made to desensitize one patient with active and severe endophthalmitis following extracapsular extraction. This resulted in aggravation of the process, and it was necessary to enucleate the eye because of the continued inflammation six weeks after the extraction.

One patient with only one eye was found to be fairly sensitive. He was successfully desensitized and then an extracapsular extraction was performed. There was considerable residual cortex following this operation, but recovery was uneventful. I feel that desensitization in this case was an important factor in the obtaining of the good final result.

COMMENT

Approximately 5 per cent of the 700 patients with cataract tested by the intradermal test with bovine lens antigen were found to show cutaneous reactions of + + or greater and were regarded as being truly hypersensitive to lens protein.

As was anticipated when this investigation was undertaken, many confusing and incongruous results were obtained. On the other hand, a definite train of observations supporting the theory of phaco-anaphylactic endophthalmitis was seen to unfold itself. The main difficulties encountered consisted in properly evaluating the cutaneous reactions and in properly interpreting the various postoperative ocular reactions.

It seems improbable that the routine testing for hypersensitivity to lens protein will ever come into general use. Two reasons for this are the rarity of true endophthalmitis phaco-anaphylactica and the increasing prevalence of the intracapsular method of extraction. However, there are instances in which the test is definitely indicated and, as I have attempted to show, in which desensitization means the restoration of vision to an otherwise permanently blind patient.

No evidence that hypersensitivity to lens protein is congenital was found. I am of the opinion that the same processes which allow the metabolic changes to occur in the lens resulting in the formation of cataracts also allow the absorption of sufficient lens protein by the body to result in a certain degree of sensitivity. Furthermore, the longer this absorption has been taking place and the more mature the cataract, the greater the sensitivity becomes. The reason that this sensitivity does not occur in all patients with cataract probably lies in the faulty formation of antibodies exhibited by these patients. However, the degree of sensitivity produced in this manner is seldom, if ever, great and is not likely to contribute to severe endophthalmitis following operation. The dangerous degrees of sensitivity are to be found after the capsule of the lens has been opened by some mechanical method and a large amount of cortical material has been made available for absorption over a more or less limited period of time.

It seems that the sensitivity test is especially indicated in the case of a patient with one eye in whom the capsule of the lens of the other eye was opened prior to enucleation.

In the patient who has experienced an abnormal and unaccounted for postoperative reaction following the extraction of a cataract and in whom a capsulotomy is contemplated, a sensitivity test is essential. In such a case the encapsulated lens material which is freed by the secondary operation may set up destructive inflammation. In every patient who has experienced endophthalmitis following an operation on one eye a sensitivity test should be made before an operation on the other eye is undertaken.

Every patient who shows a positive reaction to lens protein of + + or more prior to operation should receive desensitizing injections until there is no reaction to the skin test for a period of two weeks. The maximum dose used in the desensitizing injections should be continued

after operation and until the eye that was operated on is entirely healed and the absorption of the lens material has been completed.

Desensitization should not be undertaken during the active stage of endophthalmitis phaco-anaphylactica. The desensitization in all probability could not be accomplished before the endophthalmitis has run its natural course, and the inevitable focal reactions to the injections would only increase the severity of the ocular inflammation and result in greater residual damage to the eye.

Intracapsular extraction should be attempted in all favorable cases when there is any reaction to the cutaneous test with lens protein. If the capsule ruptures, the anterior chamber should be thoroughly irrigated and all the cortical material removed. These statements hold true especially for the patient who shows a marked hypersensitivity and who has not been desensitized.

Desensitization must be started with care and the dosage increased according to the degree of the local, focal and general reactions obtained. No fear about the patient's welfare need be felt if this program is carried out. The initial dose should be 0.1 or 0.2 cc. of about a 2 per cent solution of lens protein. The dosage should be increased about 0.2 cc. at a time until 1 cc. is reached, and then it may be increased by somewhat larger steps until 4 or 5 cc. is being given at each injection. A focal reaction is the sign that the amount used should be repeated or decreased rather than increased at the next injection. A general reaction, if mild, may be disregarded. The injections should be given about every four days subcutaneously on the flexor surface of the forearm, where the local reactions may be easily studied.

THE BIOCHEMISTRY OF THE LENS

IV. THE ORIGIN OF PIGMENT IN THE LENS

JOHN G. BELLOWS, M.D.*

CHICAGO

In the development of the crystalline lens, a yellowish color appears in its central or nuclear layer in late adult life. This occurs not only in the lens of human beings but in that of other animals. Vogt [1] stated that the lens of a calf is uniformly colorless, while that of an old cow is yellow. Walls [2] reported that the lenses of certain animals, such as squirrels, normally have a yellow color, which he concluded may be utilized as a color filter for visual purposes. Walls was able to extract a colored substance from such lenses in cold 2 per cent potassium hydrate and called this substance lentiflavine. He could not extract such a substance from brown and black cataract of human beings and considered the substance extracted by Gifford and Puntenny [3] to be of a different nature. He felt that the use of heat required in their method of extraction would in all probability hydrolyze the constituents of the lens and cause changes in the substance extracted.

Examination of the lens by means of a slit lamp reveals in nearly all persons over middle age a faint yellow or brown color in the nuclear portion. From this stage, which is characteristic of nuclear sclerosis, all degrees of increasing pigmentation are found up to a mahogany brown, which has been described by the term of cataracta brunescens. Rarely a lens is seen which appears almost black (cataracta nigra). The latter conditions arise as a result of the same process as the former but carried out to a greater degree, according to Hess,[4] Elschnig and Zeynek [5] and Gifford. There is no sharp line of separation between nuclear sclerosis and cataracta brunescens or cataracta nigra.

Various explanations for the origin of this color have been advanced, namely: (1) a physical phenomenon due to the increased refractive index;

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1. Vogt: Lehrbuch und Atlas der Spaltlampenmikroskopie des lebenden Auges, Berlin, Julius Springer, 1931, vol. 2.

2. Walls, G. L.: Personal communication to Dr. S. R. Gifford. Walls, G. L., and Judd, H. D.: Brit. J. Ophth. **17**:705, 1933.

3. Gifford, S. R., and Puntenny, J. S.: Am. J. Ophth. **16**:1051, 1933.

4. Hess, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1905, vol. 6, chap. 9.

5. Elschnig and Zeynek: Ztschr. f. Augenh. **29**:408, 1913.

(2) the presence of blood pigment; (3) bile pigment in the lens; (4) lipoids originating either in the lens itself (endogenous) or from distant sources (exogenous), and (5) the formation of melanin or a melanin-like substance in the lens. In the report of Gifford and Puntenny the literature concerned with the various theories was thoroughly covered. The conclusion reached by these authors was that some ferment, such as "dopa oxidase," reacts with a substance developed from the lens protein to produce a pigment. Elschnig and Zeynek, Takeishi,[6] Gifford, Waelsch[7] and others have come to the conclusion that melanin, in the sense defined later, is the underlying cause of the color in the brown and black cataract.

Two other substances in the lens which have not been suggested previously as a possible cause of the color are vitamin A, especially carotene, and vitamin B_2, both of which are nearly always associated with yellow.

Two brown lenses were tested for carotene by the color reaction of Levine and Bien.[8] After crushing the dried lenses the material was added to 2.5 cc. of chloroform. This was placed over an equal quantity of a mixture of formaldehyde and sulphuric acid in a test tube. A violet zone between the two layers appeared. This is the characteristic color reaction for vitamin A.

Vitamin B_2 is found in normal lenses according to Fischer[9] and accounts for part of its fluorescence in ultraviolet light. However, it is absent in cataractous lenses and diminishes in amount with the age of the animal.

This report is the result of work done on the formation of pigment from substances which are found normally in the lens. In order to avoid confusion of terms, melanin is defined as being an organic dye or pigment found in the skin, eye and central nervous system of all animals. It contains carbon, nitrogen, hydrogen and oxygen. According to the recent studies of Waelsch,[10] there is always a considerable amount of sulphur present. The latter substance is of great importance, as it is contained in cysteine, which is the reduced form of the sulphydryl group and which is of prime importance in melanogenesis. Even if allowances are made for the different methods used and the source from which the pigment is obtained, there are such marked variations in the percentage composition of melanin reported by dif-

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6. Takeishi: Abstr., Klin. Monatsbl. f. Augenh. **66**:946, 1921.

7. Waelsch: Arch. f. Augenh. **108**:443, 1934.

8. Levine, V. E., and Bien, G. E.: Proc. Soc. Exper. Biol. & Med. **31**:581, 1934.

9. Fischer, F. P.: Arch. f. Augenh. **108**:527, 1934.

10. Waelsch: Ztschr. f. physiol. Chem. **213**:35, 1934.

ferent writers that many are led to believe that under the term melanin are grouped a whole series of more or less chemically related bodies.

Gifford and his associates,[11] from a study of the permeability of the lens capsule, concluded that it is extremely improbable that a complex substance such as melanin can pass through it. Therefore, it seems likely that melanin in the lens must originate in situ; and thus the lens would show another characteristic of the skin to which it is related embryonically, namely, pigmentation. Another similarity of the lens and skin which may be mentioned in passing is the presence of large quantities of the cysteine-cystine group and of insoluble proteins which resemble each other physically (albuminoids in the lens, keratin in the skin).

That melanin can originate in the skin independently of the circulation has been demonstrated by Meirowsky.[12] This was done by carefully freeing the skin from all blood and then incubating it at a temperature of 56 degrees. This resulted in an increased pigmentation of the skin which Meirowsky explained was due to changes in the cells, forming pigment in situ. Furthermore, he showed that in the process of pigmentation a substance escapes from the nucleus of the cell into the cytoplasm and is gradually changed into melanin granules. Recently this theory of Meirowsky was confirmed by the work of Ropshaw.[13] The latter explained this phenomenon of pigmentation as follows: Protamine is split off from the nucleoproteins in the nuclei of the cells and escapes through the nuclear membrane out into the cytoplasm, where under suitable conditions it is precipitated and reacts with cysteine to form melanin. This theory of Ropshaw has the advantage over the older theories of melanogenesis, such as those of tyrosine-tyrosinase and the dopa oxidase reaction (Bloch), in that cysteine and protamine are actually present in the pigment-forming tissues while other theories assume the presence of tyrosinase or dopa oxidase, neither of which has been demonstrated in the human body.

Since the cysteine-protamine reaction produces a pigment under suitable conditions it was thought that the same principle might be that underlying the production of the color in the brown and black cataract. The constituents necessary for this reaction are present in the lens in the form of glutathione and nucleoprotein. Glutathione, which is a tripeptide composed of the amino-acids cysteine, glutamic acid and glycine, is found in relatively large quantities in the normal lens. The cysteine

11. Gifford, S. R.; Lebensohn, J. E., and Puntenny, I. S.: Arch. Ophth. **8**: 414, 1932.

12. Meirowsky, E.: Ueber den Ursprung des melanotischen Pigmenten der Haut und des Auges, Leipzig, W. Klinkhardt, 1908; Centralbl. f. allg. Path. u. path. Anat. **20**:301, 1909.

13. Ropshaw, H. J.: Am. J. Physiol. **103**:535, 1933.

portion of this tripeptide is the important one in the oxidation and reduction reactions and gives a color reaction with sodium nitroprusside.

According to Krause,[14] nucleoprotein is present in small quantities in the lens. Mathews [15] stated that this substance is present in all nuclei and consists of an acid portion—nucleic acid—and a basic portion—histones and protamines. The latter, according to Kossel,[16] who has investigated protamines thoroughly, are proteins of the most elementary kind. He has isolated arginine, histidine and lysine most frequently from them; less often were found valine, proline, tyrosine, serine, alanine and tryptophan. Because of its strong basic character protamine is easily extracted by strong or dilute acids.

EXPERIMENTAL METHOD

The three experiments reported here were performed to determine (1) whether lens substance yields protamine by Kossel's method of extraction; (2) whether the protamine thus obtained reacts with cysteine to form melanin, and (3) whether a normal lens under favorable conditions becomes pigmented in vitro.

EXPERIMENT 1.—*Extraction of protamine from lenses by Kossel's method suitably modified.*

The lenses of 200 fresh normal bovine eyes were removed individually from their capsules. The lenses were chopped up and ground with quartz sand in a mortar. To this material twice its volume of 1 per cent by weight of sulphuric acid was added, and the whole was placed in a shaking machine for one-half hour. The fluid portion was poured off into a container, and the mass was again extracted with a solution of sulphuric acid. This process was repeated until a sample of fluid no longer gave a precipitate with alcohol.

The combined fluid portion was strained through gauze to remove the coarse material and was then centrifugated. The supernatant fluid was filtered through a Seitz filter, as suggested by Ropshaw. To the filtrate three volumes of 95 per cent alcohol was slowly added with frequent stirring. The fluid became milky and within a few minutes snowlike flakes were precipitated. The precipitate was collected by centrifugation and the supernatant fluid was poured off. Boiling distilled water was used to dissolve the precipitate, and the insoluble portion was removed by means of filtration. The extract was again precipitated from the clear filtrate with three volumes of alcohol, and then it was dried in a warm chamber.

A solution of this material gave a positive reaction to the biuret, Millons and Hopkins-Cole tests. Molisch's test was negative. A precipitate formed with potassium ferrocyanide in a neutral and a slightly alkaline solution. Therefore, the extract was a basic protein (histone or protamine).

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14. Krause, A. C.: Yale J. Biol. & Med. **5**:1, 1932.

15. Mathews, A. P.: Physiological Chemistry, New York, William Wood & Company, 1921.

16. Kossel, A.: The Protamines and Histones, translated by W. V. Thorpe, New York, Longmans, Green & Company, 1928.

EXPERIMENT 2.—*Reaction of the basic protein (histone or protamine) with cysteine.*

Sorenson's phosphate buffer solutions were prepared of the following p_H: 5.4, 6.6, 6.8, 7, 7.2, 7.6 and 8. Three series of solutions were used. One series (series 1) of seven test tubes contained 5 cc. of the aforementioned solutions with equal amounts of a 1 per cent solution of cysteine hydrochloride and a small quantity of the extracts of the soluble lens or protamine. For controls series of test tubes called series 2 and 3 contained the buffer solutions either with the cysteine alone or with the lens extract alone.

Within one-half hour a snow-white flocculent precipitate formed in all the test tubes of series 1 except those in which there were solutions of p_H 6.6 or less. The control series 2 and 3, which contained cysteine in buffer solution and lens extract in buffer solution, respectively, did not yield a precipitate. At the end of seventy-two hours the precipitates darkened and at the end of one week they became brownish black (fig. 1).

Interpretation.—Ropshaw's work on the melanogenesis of the skin led him to believe that cysteine in a nascent form reacts with the protamine to produce a pigment. Samples of fluid which were pipetted off from the series in which the pigment forms were tested by the

Fig. 1.—The reactions of cysteine and lens protamine in the solutions of various p_H. *1* shows the reaction at p_H 8; *2*, at p_H 7.6; *3*, at p_H 7.2; *4*, at p_H 7; *5*, at p_H 6.8; *6*, at p_H 6.6, and *7*, at p_H 5.4. At p_H 6.6 or less no reaction occurred.

nitroprusside reaction for cysteine and were found to yield a negative result. This indicated that oxidation had occurred. On the other hand, the test for cysteine gave positive results in the samples taken from the acid solutions in which precipitation and pigmentation did not take place. The exact nature of the protamine-cysteine reaction and the chemical nature of the substance formed were undetermined.

EXPERIMENT 3.—*An attempt to produce a condition resembling cataract nigra in vitro.*

A bovine lens was cut into two parts. One half of the lens was placed in test tube *A* and the other half in tube *B;* the tubes contained phosphate buffer solution p_H 5.4 and were kept in an incubator at 37 C. for twenty-four hours. In another test tube (*C*) a lens was placed in a solution of equal parts of 1 per cent cysteine and phosphate buffer solution p_H 7.6. At the end of twenty-four hours the fluid in test tube *A* was poured off, and equal volumes of 1 per cent cysteine hydrochloride and a phosphate buffer solution p_H 7.6 were added. The medium of test tube *B* was changed to p_H 7.6 without the addition of cysteine. The tubes were kept at room temperature. At the end of seventy-two hours the lens in test tube *A* showed a darkening in its superior portion which, after eight days, became

quite dark, the pigmentation having extended gradually downward with diminishing intensity (fig. 2). The lenses in *B* and *C* did not show any change.

Interpretation.—In test tubes *A* and *B* the protamine was split off from the nucleoproteins by hydrolysis which, after the p_H was changed to the alkaline side, was free to react with the added cysteine to form pigment in the lens of test tube *A*. In test tube *B* the acid solution caused hydrolysis and freeing of protamine, but apparently there was not enough free cysteine in the lens to cause an appreciable darkening. No change occurred in test tube *C* because nucleoprotamine does not hydrolyze in an alkaline solution.

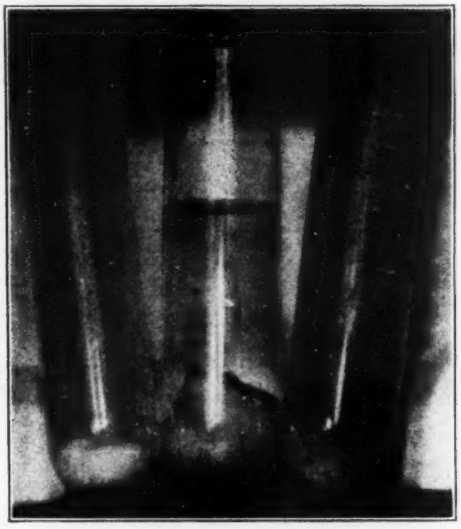

Fig. 2.—*A* shows a test tube with a lens hydrolyzed in a solution of p_H 5.4 to free the protamine and then placed in a solution of cysteine buffered to p_H 7.6. The lens became dark. *B* shows a test tube with a lens hydrolyzed in a solution of p_H 5.4 to free the protamine; no cysteine was added. There was no change of color. *C* shows a test tube with a lens, which was not previously hydrolyzed, in a cysteine solution at p_H 7.6. There was no change of color.

THEORETICAL CONSIDERATIONS

From the experiments presented here one may describe the possible origin of the yellow color of nuclear sclerosis of the lens as follows: The nuclei of the lens fibers are known to disappear in the older or central part of the lens. The disintegration of the nuclei of the lens fibers frees the protamine from the nucleoproteins. The central portion of the lens is the most alkaline, according to Krause (the p_H of the lens diminished from the inside outward). This state of alkalinity forms a suitable medium for the protamine-cysteine reaction. With the course

of time an amount of colored substance is formed which is sufficient to give the visible yellow color to the nuclear portion of the lens.

The greater degree and extent of pigmentation found in brown and black cataract is brought directly about by the increased state of sclerosis. More nuclei are destroyed and a greater amount of protamine is set free. This would permit the formation of a greater quantity of pigment. If the amount of sclerosis is moderate and does not extend to the periphery of the lens, the color of the lens is brown. On the other hand, if the sclerosis is extreme more nuclei are involved and a larger quantity of protamine is available to produce the maximum degree of pigmentation. This gives the lens a dark or black appearance.

From the foregoing considerations one would not expect an increase of pigmentation in a brown lens when placed in a suitable medium, for in such a lens the protamine has been utilized in the course of the development of the brown cataract. Thus, several brown lenses which were hydrolyzed in a solution of p_H 5.4 for twenty-four hours and then placed in a buffer solution of p_H 7.6 with cysteine showed no appreciable darkening. Likewise, cortical cataractous lenses treated in a similar manner remained unchanged. This affords an explanation for the absence of color in the latter condition. One may assume that the protamine freed by the hydrolysis during the formation of the cortical cataract is further broken down along with alpha and beta crystalline proteins into the secondary cleavage products. These are the amino-acids, peptides and peptones, which are readily diffusible through the lens capsule. Furthermore, the p_H of an immature and of a mature cataract was found to be 6.6 by Labbé and Lavagna.[17] As shown in the experiments reported here, the cysteine-protamine reaction does not take place at this p_H.

SUMMARY

The experiments described here demonstrate the presence of basic proteins (histone and protamine) in the lens.

Protamine extracted from the lens reacts with cysteine to produce a black pigment.

A normal lens which is subjected to hydrolysis becomes pigmented when it is placed in a slightly alkalinized solution of cysteine.

These experiments support the theory of protamine and cysteine reaction in melanogenesis.

A theory is offered that the color of the lens in nuclear sclerosis and its extreme types—brown and black cataract—arises as a result of a similar reaction. The protamine, which is required, is derived from the disintegration of the nuclei in the sclerotic portion of the lens.

17. Labbé and Lavagna, quoted by Krause, A. C.: Am. J. Ophth. **17**:502, 1934.

NOTE BY DR. SANFORD R. GIFFORD

Because of a report by Puntenny and myself on this subject in 1933 [8] it seems that a note expressing our present views of the matter will avoid needless confusion. In that report previous work was reviewed and the results of some experiments on pigment-producing substances in the lens were reported. Tyrosine was present to the amount of about 6 per cent in dried lens substance, but all was in a combined form which did not react with tyrosinase to produce a colored substance. Alkaline solutions of di-oxyphenylanine (dopa), however, caused cataractous lenses immersed in them to assume a dark color. This occurred more rapidly in lenses previously dark (cataracta brunescens) and occurred most rapidly and completely in a few naphthalene cataracts. The reaction occurred to a variable extent with clear rabbit lenses. These observations agreed with those of Bloch and others on reactions in the skin to dopa, and on the basis of this work the following statement was made: "This seems to offer evidence that this substance is present in such lenses which reacts with dopa to form a brown colour and that this substance is present in greatest amount in cataracta brunescens." It was also stated, however: "An objection to the method is the time required for the penetration of fluids into the lens, during which time the solution itself has turned dark." This spontaneous oxidation of alkaline dopa solution, it was recognized, involved the possibility that the color developing in the lens after immersion in such a solution was due to absorption of melanin from the solution itself. The same might be said of the dark granules found in sections of the lens placed in the solution, as even though the solution was changed frequently it became colored during the time it was allowed to act. It was considered, however, that since the lenses became darker than the solutions and since this was most marked with the brown cataracts and naphthalene cataract, it did indicate the presence in the lens of a substance which reacted with dopa.

The matter was not considered closed, however, and Dr. Bellows was encouraged to pursue it further. His application of the work of Ropshaw (published three months before our report was read, but unfortunately not known to us) to the problem has put our observations and the whole subject of melanogenesis in the lens in a new light.

The obvious advantage of Dr. Bellows' method of attack is that he employed a colorless solution which remained colorless, the color developing only in the lens material. This obviated the objection which we were unable to overcome of adsorption from the solution itself and showed definitely the production of melanin in the lens substance under his experimental conditions. In view of this, must the reactions in our tests be interpreted as due to adsorption of melanin from the solution, or may they be explained according to Ropshaw's theory of melano-

genesis? It will be remembered that some of our lenses, especially that with the naphthalene cataract, turned almost entirely black. Ropshaw stated that protamine in alkaline mediums turns dark when dopa is added. He referred to the autoxidation of dopa, which led the opponents of Bloch to consider it merely as an indicator of alkalinity. The same is true, according to Ropshaw, of epinephrine, and he expressed the belief that the dark granules found in the skin after treatment with epinephrine are probably granules of protamine stained with epinephrine. May we not believe, then, that the protamine which Dr. Bellows has shown to be present in the lens was in our lenses, especially in that with the naphthalene cataract, in part hydrolyzed so as to stain with dopa in the manner observed? The spontaneous development of a brown color in a lens with a naphthalene cataract which becomes darker on exposure to air is well known and was observed during some of our former work on animals. It brings up the question of whether this may not be due to the action of naphthalene on the nuclei of the lens, with liberation of protamines, which would offer as good an explanation of this phenomenon as has been proposed.

There are, needless to say, difficulties in explaining the slow development of color in certain lenses to such a degree as to produce the picture of cataracta brunescens. Further work is being done on this subject, but it seems that the conception of melanogenesis in the lens based on Ropshaw's theory, with the experimental evidence that conditions making such melanogenesis possible are present in the lens, is worth reporting at this time.

Clinical Notes

CURVED CATARACT KNIFE AND ITS ADVANTAGES

R. Townley Paton, M.D., New York

The following description of the advantages to be obtained from the use of a knife curved on the flat edge, the convexity being on the upper surface when the knife is held in the operative position, is presented because my ophthalmologic friends say that both the instrument and the technic used have merits.

No mention appears to have been made in the literature of the employment of a curved cataract knife for making the section. The

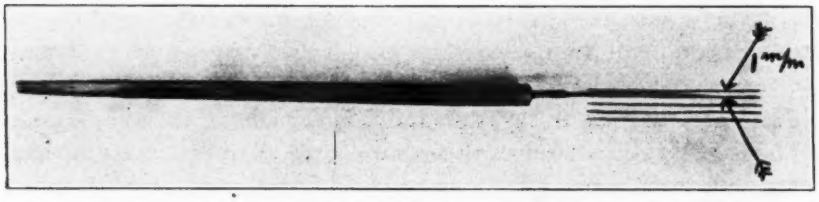

Fig. 1.—A curved cataract knife placed with the sharp edge down.

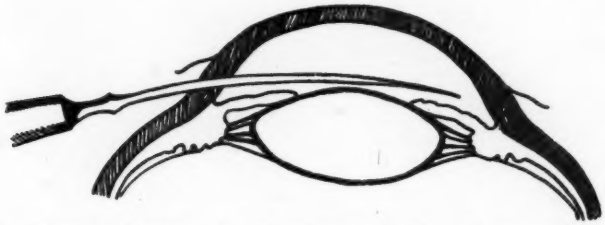

Fig. 2.—A diagram showing the advantage of using the curved blade in avoiding the iris and lens and the necessity of depressing the handle of the knife in making the counterpuncture.

knife may be used to advantage in all operations for cataract, but especially in cases in which there is a shallow anterior chamber. The technical difficulties of putting the curve in the blade of a knife of any standard make are not great. Retempering the steel after the curve has been put in adds little to the cost, and the knife may be resharpened as many times as the ordinary straight-bladed knife. It is of utmost importance, however, that the radius of curvature from the point to the heel be uniform. The best curvature for ordinary use should not exceed 1 mm. below the horizontal, as shown in figure 1.

The difficulty of making the counterpuncture with such a knife might seem to be a slight handicap, but this was never found to be the case as long as a curvature of not more than 2 mm. was exceeded. The point of the knife is directed exactly, as with the straight blade, with

the exception that a slight downward movement of the handle to compensate for the curvature of the knife is added to the forward movement. Until the surgeon has become accustomed to using the knife I suggest that the lesser curvature be used, even if the eye operated on has a very shallow anterior chamber. To obtain the best results the surgeon with every cutting movement of the knife should follow the radius of curvature. On account of the lessened upward pressure of the lens and iris against the flat surface of the knife there is considerably less binding of the knife at the edges of the section. Even in the ordinary uncomplicated cases this is striking. It has been found that there is less danger of cutting the iris and getting incarcerated fragments in the eye with increased tension or when the patient is uncooperative. The slightly beveled edges obtained give better approximation and with the slight downward pressure exerted by the lids after the eye is closed give more reassurance of an uncomplicated recovery.

No contraindication has been found in the various types of flap operation. Since the curvature is in opposite directions for the right and the left eye, the danger of inserting the knife the wrong way up is eliminated.

SUMMARY

Safety to the iris is assured in instances of a shallow anterior chamber.

The curve coapts to the curve of the eyeball.

A beveled incision helps to a larger and more compact healing surface.

The binding, sometimes noticeable when the lens bulges forward, is obviated by the use of this knife.

The knife lends itself to operation on the conjunctival flap.

The knives may be obtained from E. B. Meyrowitz, 520 Fifth Avenue, New York.

AN IMPROVED TECHNIC FOR DISSECTION OF THE LACRIMAL SAC

J. H. Hulka, M.D., Long Island City, N. Y.

In dissecting the lacrimal sac for the purpose of dacryocystectomy or for effecting permanent drainage by one of the several well described methods, the surgeon usually experiences difficulties of two kinds: first, excessive bleeding which constantly obscures the operating field and, second, loss of anatomic orientation.

These difficulties are easily remedied by a slight modification of the operative technic, and operation on the lacrimal sac, which is frequently considered as technically rather difficult, becomes a simple and clean procedure.

IMPROVED TECHNIC

The one refinement of the technic consists in using a higher concentration of epinephrine in the procaine hydrochloride used for infiltration anesthesia. The usual surgical concentration of epinephrine is 1 : 100,000 in 1 or 2 per cent procaine

hydrochloride. By adding to this epinephrine-procaine hydrochloride mixture, obtained in ampules, 1 drop of sterile, but not boiled or autoclaved, solution of epinephrine (1:1,000) for each cubic centimeter of the original solution, the concentration increases to about 1:20,000. Such a concentration has a far better hemostatic effect in vascular tissue, and though I have used it in a great number of operations on vascular tissues (nasal membranes or tonsils) I have never observed any ill effects. Necrosis from epinephrine has been reported only in poorly vascularized subcutaneous tissues which are seen only in general surgical procedures.

Infiltration with this solution is begun at the supra-orbital notch and is continued rather close to the periosteum along the inner orbital margin. After the injection, the infiltrated and bulging tissues are massaged to bring them back into their original anatomic relations. The anterior ridge of the lacrimal fossa can then be easily palpated with a finger.

A fine hypodermic needle is plunged into the lacrimal fossa above the fundus of the sac. That is the region where, in the later stage of the operation, bleeding usually occurs. The point of insertion is about 3 mm. above the inner canthus and from 3 to 5 mm. temporally from the upper end of the palpable anterior lacrimal ridge. The needle should point toward the opposite ear. After the point hits the bone, the needle is inclined toward the opposite mandibular angle. After a little palpation with the point, it can be felt passing between the fundus of the sac and the lacrimal fossa. A few drops of the solution is then injected.

The anterior lacrimal crest is again located with the finger, and its course is marked into the skin by the impression of the round end of the handle of a scalpel. The incision is made exactly 3 mm. nasally from this curvilinear impression. The direction of the scalpel is perpendicular to the nasal wall, and the scalpel cuts deeply into the tissues to divide them down to the periosteum. The length and shape of the line of incision are as usually described, beginning from 2 to 3 mm. above the canthus and running parallel with the curvature of the orbital margin.

The incision should not be more than 3 mm. distant from the anterior lacrimal crest, because about 5 mm. nasally from the crest the angular vein and artery are located. There is usually some bleeding from the upper end of the incision which can be promptly controlled by hemostats.

No retraction is done toward the nasal side, and little or no retraction is necessary toward the ocular side. The soft tissues are separated from the periosteum and pushed toward the eye. The elevation of tissues proceeds then toward the lacrimal crest and over the lacrimal sac. The best instrument for this procedure is the blunt end of a Stevens scissors. In the process of separation the rigid canthal ligament remains attached to the bone, so that the most important landmark for further dissection is easily and clearly identified.

In order to elevate the sac from the fossa, one begins at the fundus above the canthal ligament. The attachment is formed in this place by rigid fibers, which are best divided close to the periosteum with an old cataract knife. If the injection needle is properly plunged into this region, there is little bleeding even during this part of the operation.

The nasal side of the sac is then separated from its bed by blunt dissection, and finally, with the sac fully visualized and identified, the canthal ligament is divided. The operation is finished according to the type chosen.

COMMENT

Dissection of the lacrimal sac from the nasal side is suggested in Meller's textbook,[1] and also by Fleischer in Axenfeld and Elschnig's textbook.[2] Both authors, however, advised dissection of the soft parts by layers. It is during this stage of the operation that the surgeon may fail to retain his anatomic orientation.

Direct incision toward the periosteum of the nasal process of the maxilla and separation of the soft parts from the bone without the use of a raspatory give the surgeon definite landmarks—bone, and the inner canthal ligament—which are easily found and cannot be lost.

This type of incision and the use of a procaine hydrochloride with a higher concentration of epinephrine are technical details which I have never seen described.

1. Meller, J.: Augenärztliche Eingriffe, ein kurzes Handbuch für angehende Augenärzte, Leipzig, J. Safář, 1918.

2. Fleischer, J., in Axenfeld, T., and Elschnig, A.: Augenärztliche Operationslehre, Berlin, Julius Springer, 1922, vol. 2, p. 1541.

Ophthalmologic Review

VITAMINS

CLINICAL EVIDENCE OF NECESSITY OF VITAMINS FOR FUNCTION OF OCULAR TISSUE

ARTHUR M. YUDKIN, M.D.
NEW HAVEN, CONN.

Many years before the discovery of the vitamins, the belief was widely held that a perfect diet consisted of proteins, fats, carbohydrates and inorganic salts. Thus the chemical analysis of a food became a practical and reliable index of its nutritive value. In the last twenty-five years scientific investigators have somewhat altered this conception by demonstrating that animals fed these energy-producing substances cannot maintain growth and health if the materials used are chemically pure. Their findings suggested that unrecognized elements other than the energy-producing substances found in the tissues of plants and animals are essential constituents of the diet. The full significance of these facts was not realized until the findings were interpreted in the light of the deficiency diseases already known to the medical investigator. Thus the vitamin hypothesis was formulated.

What are the vitamins? They are substances that are indispensable in the maintenance of the health and normal growth of all living cells. The vitamins do not furnish energy, as do the proteins, fats and carbohydrates, but they may be classified with the hormones and the inorganic elements such as iodine, copper and manganese. These substances, according to some biochemists, may be looked on as stimulating or conditioning agents of cell metabolism, perhaps as a type of biochemical catalyzer.

In the early days of their discovery the vitamins were named according to their solubilities and with a designating letter. Further experimental investigation revealed outstanding pathologic symptoms when the appropriate vitamin was absent, and a system of nomenclature was developed in which each vitamin was labeled according to the disease produced by its deficiency. This nomenclature did not find a universal acceptance, and thus it was agreed that a system of letters be adopted to designate the accessory food factors.

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Sherman expressed the belief that the vitamins should not be grouped together under one head, for they are not sufficiently similar or related in chemical nature or nutritional function. Vitamins are known to be of the greatest importance in animal nutrition. So far as their rôle in the nutrition of man is concerned, the significance of the vitamins in some cases is either not known or imperfectly understood. It is necessary in this study to allude to the laboratory investigations on this subject, for they are in fact more advanced than the clinical researches in this field. The conception of the vitamins is now acknowledged as one of the fundamental principles of nutrition. It is generally agreed that the vitamins now to be discussed are necessary as a whole or in part for the maintenance of the growth and health of the experimental animal.

VITAMIN A

Nature.—The chemical nature of vitamin A is not fully understood; nevertheless, it is now possible, on the basis of many contributions by Karrer,[1] Kuhn [2] and Heilbron [3] and their associates, to state with considerable confidence that vitamin A has a structure which is closely related to the carotenoid pigments and the terpenes of essential oils (Jackson [4]). Work published during 1930-1931 has brought further confirmation of the claim of von Euler and his co-workers [5] (1928-1929) that the pigment carotene possesses vitamin A. The relation between cod liver oil and carotene was definitely established by the work of Moore,[6] which showed that the pigment was transformed in the animal body into a colorless substance which is stored in the liver. Carotene is a yellow coloring matter present in carrots and many other vegetables. It is found also in conjunction with, and hidden by, the green substance chlorophyll in the leaves and other green parts of plants. When green and yellow vegetables containing carotene are eaten, the carotene is more or less completely absorbed from the digestive tract and subsequently transformed into vitamin A in the animal body. The conversion of carotene into vitamin A occurs probably in the liver. Several forms of carotene are known to the laboratory worker. The naturally occurring alpha and beta carotenes serve as sources of vitamin A for animals, but the so-called isocarotene prepared in the labora-

1. Karrer, P.; von Euler, H.; Hellstrom, H., and Rydbom, M.: Svenska chem. tijdschr. **43**:105, 1931.

2. Kuhn, R., and Lederer, E.: Naturwissenschaften **19**:306, 1931; Ber. d. deutsch. chem. Gesellsch. **64**:1349, 1931.

3. Gillam, A. E.; Heilbron, I. M.; Hilditch, T. P., and Morton, R. A.: Biochem. J. **25**:30, 1931.

4. Jackson, R. W.: Yale J. Biol. & Med. **5**:253, 1933.

5. von Euler, B.; von Euler, H., and Hillström, H.: Biochem. Ztschr. **203**: 370, 1928. von Euler, B.; von Euler, H., and Karrer, P.: ibid. **290**:240, 1929.

6. Moore, T.: Biochem. J. **23**:803 and 1267, 1929.

tory by suitable treatment of carotene is without growth-promoting properties. Further investigations may reveal many more isomeric forms of carotene.

Source.—The usual food sources of vitamin A are milk, butter and eggs. Certain fish oils, such as cod liver oil, halibut liver oil and salmon oil, are rich in it, and cereals and muscle tissue poor. Space does not permit the presentation of a catalog of the foods that contain vitamin A. I recommend all who are interested to read the writings of Sherman and a publication of the Medical Research Council,[7] in which the results obtained by various investigators in regard to the vitamin A content of typical foods have been tabulated.

Pathologic Conditions Induced by Vitamin A Deficiency in Animals.—From the earliest days of the study of disturbances due to vitamin deficiency it was observed that animals deprived of adequate supplies of vitamin A showed a tendency to lose weight and contract infections, particularly those of the respiratory tract. Another disorder more closely associated with a shortage of vitamin A was the ocular condition described as xerophthalmia. This condition, involving the lacrimal glands, conjunctiva and cornea, may be seen in the majority of rats maintained for a prolonged period on a diet deficient in vitamin A. Another involvement of the eye resulting from deficiency of vitamin A is hemeralopia or night blindness. Interesting experiments by Fridericia and Holm[8] showed that there is retardation of the rate of regeneration of the visual purple of the eyes in animals kept on a diet deficient in this accessory food. These results have been confirmed by Tansley.[9] Infections of the mucous membranes seem to be prevalent in these animals. Stones in the bladder and kidney are likewise a frequent disturbance. There is also evidence that anemia is produced.

Pathologic Conditions in Man Due to Vitamin A Deficiency.—Whether or not analogous disturbances are observed in man when vitamin A is lacking from the diet is a disputed question, yet many instances are recorded in which similar pathologic conditions are produced in man by nutritional deficiencies. Outstanding is the investigation of Bloch[10] in Denmark, who showed that in children deprived of vitamin A ocular conditions developed similar to those seen in experimental animals. In the light of the present knowledge, the external ocular disease prevalent among infants in Japan and described

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7. Vitamins: A Survey of Present Knowledge, Medical Research Council, Spec. Rep. Ser., no. 167, London, His Majesty's Stationery Office, 1932.

8. Fridericia, L. S., and Holm, E.: Am. J. Physiol. **73**:63 (June) 1925.

9. Tansley, K.: J. Physiol. **71**:442, 1931.

10. Bloch, C. E.: Effects of Deficiency in Vitamins in Infancy, Am. J. Dis. Child. **42**:263 (Aug.) 1931.

by Mori [11] was due to the lack of vitamin A, for when the afflicted children were given cod liver oil the disease was cured. Similar instances recorded in the literature prior to the era of vitamins may likewise be attributed to the same deficiency (McCollum [12] and the Medical Research Council [7]).

Numerous cases of night blindness have been recorded in which cures were obtained when the patients were treated with liver, liver oils and green vegetables. When the diets of these persons are analyzed they are found to be deficient in many of the vitamins, including particularly vitamin A. This form of night blindness, which has been termed deficiency hemeralopia, was common during the late war among Austrian prisoners of war in Russia. It was studied by various Austrian physicians, themselves prisoners (Zak,[13] Meissner [14] and Hift [15]). The occurrence of night blindness and keratomalacia among soldiers in a military camp north of Peiping, China, was described by Pillat.[16] He pointed out that persons with a mild form of the disease are unable to read or perform fine work in the evening; those with a severe form lose their sense of orientation on the street after sunset and cannot find their way home. As a rule in the early stages of the deficiency, night blindness is not accompanied by positive findings in the retina. At least changes in the fundus are not visible with the present methods of examination. Pillat has frequently found cases of night blindness by means of a special examination for dark adaptation. He employed for this purpose an instrument known as the Birch-Hirschfeld visual photometer.

In this country Jeans and Zentmire [17] examined a group of children with a similar instrument. From their observations they concluded that the test is satisfactory for detecting moderate degrees of vitamin A deficiency. It was noted that some children with vitamin A deficiency were mentally alert and appeared well nourished; others were underweight, appeared ill nourished and were sluggish physically and mentally, although not mentally deficient. On the other hand, some children appeared to be suffering from nutritional deficiencies, but the tests for vision in darkness indicated no deficiency of vitamin A. Innumerable reports of cases of night blindness due to disturbance of the alimentary

11. Mori, M.: Jahrb. f. Kinderh. **59**:175, 1904.

12. McCollum, E. V., and Simmonds, N.: The Newer Knowledge of Nutrition, ed. 4, New York, The Macmillan Company, 1929.

13. Zak, E.: Wien. klin. Wchnschr. **30**:592, 1917.

14. Meissner, M.: Wien. klin. Rundschau **33**:15, 1919.

15. Hift, R.: Wien. klin. Wchnschr. **31**:939, 1918.

16. Pillat, A.: Nat. M. J. China **15**:585, 614 (Oct.) 1929; Ztschr. f. Augenh. **80**:189, 1933.

17. Jeans, P. C., and Zentmire, Z.: A Clinical Method for Determining Moderate Degrees of Vitamin A Deficiency, J. A. M. A. **102**:892 (March 24) 1934.

tract or to a diet deficient in vitamin A have been published in the medical journals (Wilbur and Eusterman [18] and Tilderquist [19] in the United States, Macphail [20] in Guatemala, Spence [21] in England, Aykroyd [22] in Newfoundland, Pillat [16] in China, Ljubin [23] in Serbia, Wright [24] in India, Field in Malaya, Kubli [25] in Russia and Birnbacher [26] in Germany). Aykroyd reported several cases in which exposure to strong light precipitated an attack of night blindness. This observation confirmed in part the assumption that night blindness is caused by failure in the formation of visual purple after bleaching by strong light. Fridericia and Holm were able to demonstrate this phenomenon in rats starved of vitamin A. Many observers noted that night blindness may disappear as soon as better nourishment is given, but when the regular diet is not supplemented with vitamin A in some form more severe symptoms of deficiency may present themselves.

In man Pillat stated that xerosis epithelialis conjunctivae is usually the second stage of vitamin A deficiency.[16] This observation agreed with the clinical findings which I described [27] in animals placed on a diet deficient in vitamin A. The bulbar conjunctiva at first may show loss of luster, and the lower culdesac is filled with broken-down epithelial tissue. Frequently the lesion is accompanied by triangular white spots, known as Bitot's spots, appearing like a dense foam of soap in the palpebral fissure, with the base at the limbus and the apex directed toward either the external or the internal canthus. The lacrimal secretion does not adhere to these spots. An examination of the lacrimal secretion shows a diminution of lysozym (Anderson [28]). In the severest cases and in those of long duration Bitot's spots and the loss of luster are absent, and folds of conjunctiva take their place.

Xerosis epithelialis corneae is the next stage in a case of vitamin A deficiency. According to Pillat [16] two forms may be distinguished clinically: (*a*) prexerosis and (*b*) real xerosis of the cornea. The former

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18. Wilbur, D. L., and Eusterman, G. B.: Nutritional Night Blindness, J. A. M. A. **102**:364 (Feb. 3) 1934.

19. Tilderquist, D. L.: Minnesota Med. **16**:675 (Nov.) 1933.

20. Macphail, N. P.: Eighteenth Ann. Rep. M. Dept., United Fruit Co., 1929, p. 172.

21. Spence, J. C.: Arch. Dis. Childhood **6**:17, 1931.

22. (*a*) Aykroyd, W. R.: J. Hyg. **30**:357, 1930; (*b*) Tr. Ophth. Soc. U. Kingdom **50**:230, 1930.

23. Ljubin, Josip: Liječn vjes. glas. **53**:907, 1931.

24. Wright, R. E.: Lancet **1**:800, 1931.

25. Kubli, F.: Russk. oftal. žur. **7**:227, 1928.

26. Birnbacher, T.: Abhandlungen aus den Augenheilkunden und ihre Grenzgebiet, Berlin, S. Karger, 1927, vol. 4, p. 1.

27. Yudkin, A. M.: Ocular Manifestations of Rat Which Result from Deficiency of Vitamin A in Diet, J. A. M. A. **79**:2206 (Dec. 30) 1922.

28. Anderson, Oluf: Acta pædiat. **14**:81, 1932.

stage is far more frequent than the latter, at least in adults. Pillat described the three chief symptoms of prexerosis as (*a*) slight loss of luster of the cornea, (*b*) reduced sensibility and (*c*) the presence of xerosis-producing bacilli in the degenerated epithelial cells of the cornea.

The last stage in a case of vitamin A deficiency is a breaking down of the cornea—keratomalacia. It is a well known condition in infants, and in China, according to Chou [29] and Pillat, it may be seen in all forms and at almost any age, but more commonly in males than females. The progress of keratomalacia in adults in most instances is not as great as in infants. Pigmentation of the conjunctiva and meibomitis, according to Pillat,[30] are frequently seen accompanying the ocular disturbances.

Comment.—The ocular picture I have described is extremely rare in the United States; nevertheless cases of nutritional night blindness have been reported by Wilbur and Eusterman,[18] Tilderquist [19] and Jeans and Zentmire.[17] It has been suggested that night blindness is caused by failure in the formation of visual purple (rhodopsin). This capacity is greatly impaired in animals by a deficiency of vitamin A (Fridericia and Holm [8] and Tansley [9]), and the failure in formation is more pronounced when the animal is exposed to brilliant light. Aykroyd made a similar clinical observation in the fisher-folk of Newfoundland. When animals kept on a diet deficient in vitamin A were given the retinal tissue of the pig (Yudkin [31]) or of the calf (Holm [32]) instead of cod liver oil, they regained their normal growth, maintained good health and recovered from the ocular disturbances. These observations at once led the investigators to suggest that the retina was rich in vitamin A. Simultaneously, Moore [6] and others observed that carotene could be substituted for vitamin A in similar cases of deficiency. This led to considerable confusion, and the question arose whether the retina was rich in vitamin A or in its newly discovered precursor, carotene. Employing the best available spectroscopic and chemical methods, Yudkin was unable to detect the presence of vitamin A or carotene in the retina. Late in 1933, however, Wald,[33] working at Zurich, found vitamin A in considerable concentration in solutions of the visual purple from the intact retina and the pigmented choroidal layer of frogs, pigs and cattle. By means of spectroscopic analysis he noted that the nonsaponifiable

29. Chou, C. H.: Nat. M. J. China **16**:365 (Aug.) 1930.

30. Pillat, A.: Arch. f. Ophth. **128**:361, 1932.

31. Yudkin, A. M.; Kriss, Max, and Smith, A. H.: Am. J. Physiol. **97**:611 (July) 1931.

32. Holm, E.: Acta ophth. **7**:146, 1929.

33. Wald, G.: Nature, London **132**:316 (Aug. 26) 1933; ibid. **134**:65 (July 14) 1934.

extracts of these ocular tissues display in detail all the characteristics of oils containing vitamin A. Wald observed also that the conversion of visual purple to visual yellow is followed by thermal decomposition of the visual yellow into colorless products, among them vitamin A. He stated:

> It is probable, therefore, that visual purple is a conjugated protein in which A is the prosthetic group. In isolated retinas which have been bleached and replaced in darkness, visual yellow reverts in part to visual purple; the remainder decomposes as described to colorless products. The latter substances never reform visual purple in the isolated retina. In the intact eye this type of reversion does occur freely; it requires the co-operation of the pigment epithelium (Kühne [34]). The pigment epithelium is necessary also as a source of vitamin A, quantities of which are lost during vision.

He described a substance observed in the retinas of dark-adapted frogs which possessed no absorption bands in the visible spectrum and which he named "retinene." To this substance Wald attributed the power of generating vitamin A. As yet, this conception of the formation of vitamin A and visual purple (rhodopsin) has not been corroborated. Further study is necessary before the hypothesis can be adopted.

For many years the ophthalmologist has recognized the value of cod liver oil (vitamin A) and products of liver in the treatment of nutritional night blindness. Considerable success has been noted in the treatment of blepharospasm produced by lesions in the choroid and retina. I [35] reported improvement in cases of toxic amblyopia produced by alcohol and tobacco, and also in cases of phlyctenular keratoconjunctivitis. Twelve patients with retinitis pigmentosa were also treated with vitamin A, but during a period of two years no definite objective improvement was noted; the patients, however, thought they saw better at night. I do not believe that retinitis pigmentosa is improved by vitamin therapy. It is apparent, however, from clinical studies of many cases that inflammations of the choroid and retina produced by unknown foci of infection improve more rapidly when vitamin A is supplemented in the diet. The improvement is further enhanced if vitamin B complex is also given.

VITAMIN B COMPLEX

For some years it has been known that experimental animals require the vitamin B complex for normal growth. This vitamin was originally considered a single entity by McCollum [36] (1916) and his colleagues.

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34. Kühne, W.: On the Photochemistry of the Retina and on Visual Purple, translated by Michael Foster, London, The Macmillan Company, 1878.

35. Yudkin, A. M.: Ocular Disturbances Produced in Experimental Animals by Dietary Changes: Clinical Implications, J. A. M. A. **101**:921 (Sept. 16) 1933.

36. McCollum, E. V., and Kennedy, C.: J. Biol. Chem. **24**:491, 1916.

Later they suggested that this "water-soluble vitamin B" was identical with the antineuritic vitamin discovered by Eijkman [37] (1897). More recent work, however, revealed that the vitamin which Eijkman employed to prevent the development of, and to cure, polyneuritis in birds kept on a diet of polished rice and the vitamin which clinical investigators had used for protection against the development of beriberi in man were made up of several vitamins. In England the Biochemical Society adopted the plan of indicating the various vitamins of this complex by subscribed figures, e. g., B_1, B_2, B_3, etc. According to the Medical Research Council,[7] the following terms are at present in use in England:

Vitamin B_1 for the more heat-labile, antineuritic (antiberi-beri) vitamin, discovered by Eijkman [37] (1897). Vitamin B_2 for the more heat-stable, "P-P" (pellagra-preventive) factor discovered by Goldberger [38] and others in 1926, found necessary also for prevention of dermatitis in rats. Vitamin B_3 for a heat-labile factor of this group, described by Williams and Waterman [39] (1927-28), present in yeast and whole wheat and necessary for full normal nutrition in the pigeon. Vitamin B_4 for the heat- and alkali-labile factor described by Reader [40] (1929), present in yeast and necessary for the rat; this factor has been known previously as "vitamin B_3". Vitamin B_5 for the factor described by Carter, Kinnersley and Peters [41] (1930), which is necessary for the weight maintenance of pigeons. Factor Y for the heat- and alkali-stable factor described by Chick and Copping [42] (1930), present in yeast and many other foodstuffs, deficient in egg-white.

All the vitamins just described are found in fresh yeast. In America some workers use the term vitamin B for vitamin B_1 as defined in the report just quoted and the term vitamin G for vitamin B_2, while other investigators call the antineuritic factor vitamin F (Sherman [43]).

Even though considerable confusion is still present concerning the number of components in the vitamin B complex, it may be regarded as firmly established that vitamin B_1, in addition to affording protection against polyneuritis, is an essential factor for the cure of beriberi.

The opinion is now general that beriberi is a disease of dietetic origin. Beriberi, both in man and in animals, has been attributed to the lack of vitamin B_1 in the diet. Cowgill,[44] in his monograph on

37. Eijkman, C.: Virchows Arch. f. path. Anat. **148**:523, 1897.

38. Goldberger, J.; Wheeler, G. A.; Lillie, R. D., and Rogers, L. M.: Pub. Health Rep. **41**:297, 1926.

39. Williams, R. R., and Waterman, R. E.: Proc. Soc. Exper. Biol. & Med. **25**:1, 1928.

40. Reader, V.: Biochem. J. **23**:689, 1929.

41. Carter, C. W.; Kinnersley, H. W., and Peters, R. A.: Biochem. J. **24**: 1832 and 1844, 1930.

42. Chick, H., and Copping, A. M.: Medical Research Council, Spec. Rep. Ser., no. 77, London, His Majesty's Stationery Office, 1930.

43. Sherman, H. C.: Food Products, New York, The Macmillan Company,, 1934.

44. Cowgill, George: The Vitamin B Requirement of Man, New Haven, Conn., Yale University Press, 1934.

vitamin B, noted that in certain parts of the world, notably in the Far East, beriberi is so prevalent that it constitutes one of the most serious medical problems confronting the public health authorities. The three most important regions in which this disease is endemic are Asia, South America and Africa. Cases of beriberi have also been observed in the United States and have been reported among fishermen in New England. Beriberi continues to occur in Newfoundland and Labrador (Little [45] and Aykroyd [22a]).

Nature and Distribution.—Recent work on the vitamin B complex has shown that oats, corn, wheat, wheat embryo, the outer layers of rice, rice polishings and red kidney beans are relatively richer in the antineuritic component of vitamin B than in vitamin G (Kruse and McCollum [46]), while milk, egg white, banana and cooked fresh spinach have a preponderance of vitamin G. Yeast is an excellent source of both factors, but the clinician should remember that commercial dried brewers' yeast may vary as much as tenfold in activity (Seidell and Smith [47]). Among the tissues of the body containing relatively large amounts are the glandular organs, notably the liver, kidney and brain, all these being richer than muscle in this vitamin. Among the fruits and vegetables, tomatoes, raw cabbage and fresh spinach have been found to contain more vitamin B than orange or lemon juice, onions, lettuce or cauliflower (Cowgill [44]). For further detailed discussion of vitamin B, its chemical and physical nature, the experimental pathologic lesions and its relation to fevers and gastro-intestinal disturbances, Cowgill's monograph,[44] "The Vitamins," [48] published by the American Medical Association and the report of the Medical Research Council [7] are recommended.

Ocular Disturbances Accompanying Deficiency in Vitamin B.—Lesions in the brain have been described as characteristic of pellagra in man (Cowgill [44] and Levine [49]). Likewise, ocular disturbances have been alluded to by Cronin [50] and Levine.[49] Barletta [51] observed disintegration of the chiasmal fibers of the optic nerve in cases of avian beriberi and expressed the belief that there is a similar disturbance of the optic nerve in human beings suffering from beriberi. The lesion manifests itself in the form of central scotomas. Kagawa [52] reported favorable

45. Little, J. M.: Beriberi, J. A. M. A. **63**:1287 (Oct. 10) 1914.
46. Kruse, H. D., and McCollum, E. V.: Physiol. Rev. **9**:126, 1929.
47. Seidell, A., and Smith, M. I.: J. Am. Chem. Soc. **55**:3380, 1933.
48. Cowgill, George: The Vitamins, Chicago, American Medical Association, 1932.
49. Levine, Joseph: Pellagra as a Cause of Optic Neuritis: Report of a Case, Arch. Ophth. **12**:902 (Dec.) 1934.
50. Cronin, Herbert J.: J. Nerv. & Ment. Dis. **78**:35, 1933.
51. Barletta, Vincenzo: Rassegna ital. d'ottal. **1**:210, 1932.
52. Kagawa, S.: Mitt. d. med. Gesellsch. zu Tokio **45**:193, 1931.
53. This footnote was deleted by the author.

results in cases of retrobulbar neuritis when vitamin B was given to patients with beriberi. Shastid [54] treated patients having optic neuritis with the vitamin B complex, and from his results he concluded that the vitamin "does profoundly affect nerve tissue."

Ayuyao [55] described corneal lesions appearing during the last months of pregnancy or a few weeks after labor. He attributed the lesion to neuritis of the ophthalmic branch of the fifth nerve. When pregnancy is over the visual acuity gradually, though slowly, returns to the normal condition, and improvement of the symptoms of beriberi takes place. In the treatment of toxic amblyopia in the clinic with which I am associated, it was found that the addition to the diet of vitamin A alone did not cure all patients, but when yeast was added a more rapid recovery was noticed. However, in cases in which the optic nerve showed signs of atrophy, the addition of vitamins did not alleviate the ocular disturbance.

Comment.—Even though the ocular disturbances were cured by the addition of vitamin B to the diet, this is not conclusive proof that the ocular lesions were due to the absence of vitamin B alone in the diet, for it is known that some of the symptoms accompanying beriberi may well be due to other deficiencies. Vitamin B has an important relation to appetite and health in persons of all ages. Among other things it seems to help the normal motility of the digestive tract. The results of experimentation have shown that the intestines as well as the stomach tend to lose their normal motility when the diet is deficient in vitamin B. For the present it is important that the action of the vitamin complex be considered rather than the effect produced by the lack of vitamins B and G.

VITAMIN G

Almost all the investigators who have attempted to analyze water-soluble vitamin B into its component parts have used autoclaved yeast as a source of vitamin B_2, it being assumed that the antineuritic vitamin is destroyed by exposure for a few hours to high temperatures. It will be seen that the literature dealing with the properties of vitamin B_2 is full of contradictions. According to the Medical Research Council these descrepancies will doubtless be cleared up as the result of further investigation. In general vitamin B_2 has been found to accompany vitamin B_1 in ordinary foodstuffs. The richest known sources are liver, yeast and milk. Harris [56] in the *Annual Review of Biochemistry* (1934) stated:

> The outstanding event of the year has been the identification of vitamin B_2 (or a major component) as the naturally occurring water soluble pigment, first found

54. Shastid, T. H.: Am. J. Ophth. **12**:903 (Nov.) 1929.
55. Ayuyao, Conrado D.: J. Philippine Islands M. A. **13**:158 (March) 1933.
56. Harris, L. J.: Ann. Rev. Biochem. **3**:247, 1934.

in milk as "lactochrome" (now renamed lactoflavine) by Winter Blyth as long ago as 1879 and further studied by Bleyer and Kallmann [57] (1925) and others. The flavine present in egg white (ovoflavine) appears to be identical chemically with that in milk (lactoflavine), and to be equally active biologically, and there can be little doubt also that the flavine occurring in other tissues, such as, e. g., muscles, is equally the source of vitamin B_2 activity; whether there may be any minor variations in chemical configuration or in biological potency of the pigment as it occurs in different sources remains to be established.

It is not justifiable to assume that pellagra and vitamin B_2 deficiency are synonymous. Evidence against the identity of vitamin B_2 and a pellagra-preventive factor and against the analogous nature of pellagra in man and dermatitis in the rat is the fact that dermatitis requires a highly purified diet for its development. Pellagra is unquestionably associated with a poor and monotonous diet, and its appearance can be prevented by suitable dietary alterations. The efficiency of yeast in the prevention of the condition and the cure of the milder forms has been conclusively demonstrated.

Experimental Evidence of Ocular Disturbance.—Of interest to the ophthalmologist is the investigation of Day, Langston and O'Brien [58] on the production of keratitis and cataract in rats fed a diet deficient in vitamin B_2. Through the courtesy of Cowgill and Burack, I [35] examined dogs fed a diet free from vitamin G, but I was unable to detect any ocular disturbance. Guida and I, prompted by the work of Day, Langston and O'Brien, repeated the experiment on rats and observed ocular disturbances in the form of cataract and keratitis.

Comment.—The incidence of cataract is not any greater in cases of pellagra than in those of other types of disease. It is significant, however, that cataract develops in animals that are kept on a diet deficient in the so-called pellagra-preventing vitamin G. The question arises whether observations on the albino rat can be interpreted in terms of lenticular disturbance in man. It is not far-fetched to consider that some types of cataract in man are formed because of the lack of proper absorption from the intestinal tract of certain food substances that are necessary for the maintenance of the normal metabolism of the lens. In the present state of knowledge, one has no right to attribute the formation of cataract to the lack of vitamin G alone in the diet. It is possible, however, that the lack of the vitamin B complex in the diet alters the condition of the intestinal tract so that the body is unable to furnish the lens with its proper pabulum.

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57. Bleyer, B., and Kallmann, O.: Biochem. Ztschr. **155**:54, 1925.

58. Day, P. L.; Langston, W. C., and O'Brien, C. S.: Am. J. Ophth. **14**:1005 (Oct.) 1931.

VITAMIN D

For a number of years prior to the work of Mellanby [59] it was thought that vitamin A was the factor responsible for the cure of rickets. In 1922 McCollum and his co-workers clarified the situation by showing that cod liver oil in which the vitamin A factor was destroyed by oxidation still retained its antirachitic potency. These investigators, therefore, interpreted their experimental data as showing that the antirachitic substance is distinct from vitamin A.

In 1924 Steenbock [60] made his remarkable discovery of the change which takes place in food substances when they are irradiated for short periods with ultraviolet rays. Most foods treated in this manner become strongly antirachitic. Today every city of note has a milk establishment in which milk for daily consumption is irradiated by a process licensed to them by the Wisconsin Alumni Research Foundation. The function of vitamin D is to regulate the metabolism of calcium and phosphorus in the body. It therefore appears that vitamin D promotes the absorption of calcium and phosphorus from the intestine into the blood stream. Whether it performs this office independently or through the medium of the parathyroid gland is a question at present under discussion among biochemists.

Attention has been called to the toxicity of artificial vitamin D. Clinical experience suggests that 1,500 units of irradiated ergosterol is a suitable prophylactic dose and approximately 3,000 units a curative dose. Therefore, care must be taken by the ophthalmologist in recommending the use of vitamin D in ocular therapeutics.

Comment.—At the present time vitamin D has no place in ocular therapeutics; no experimental work has been reported in which animals with ocular disease have been benefited by its use. Recently it was noted in the clinical work of my associates and myself that a number of children presented themselves with follicular conjunctivitis for which no etiology could be established. On questioning, it was found that the patients were receiving considerable vitamin D in the form of medication as a supplement to the diet and that they were exposed to the rays of the sun. When these patients discontinued the medication and took fewer sun-baths, the ocular irritation disappeared. From the aforementioned facts it would seem that some of the cases of irritative conjunctivitis occurring in the summer may be due to an overdose of vitamin D.

VITAMIN C

It is a curious fact that, although the antiscorbutic vitamin was one of the earliest to be recognized, little progress had been made until

59. Mellanby, E.: J. Physiol. **52**:53 (Dec.) 1918.
60. Steenbock, H., and Black, A.: J. Biol. Chem. **61**:405, 1925.

recently in the direction of its concentration and isolation. Harris,[56] in the *Annual Review of Biochemistry,* stated that Tillman and his co-workers in Germany had concluded that vitamin C is identical with a reducing principle present in plant sources, probably the same as Szent-Györgyi's hexuronic acid; that King in America, having isolated a crystalline preparation of vitamin C from lemon juice, found that it possessed antiscorbutic properties, and that Birch, Harris and Ray[61] showed that there is, in fact, an unvarying correlation between vitamin C and hexuronic acid (which was renamed ascorbic acid by Szent-Györgyi and Haworth and is now called cevitamic acid). No doubt remains, therefore, in regard to the specificity of the substance.

Distribution.—Birch, Harris and Ray[61] devised a micromethod for the determination of the presence of vitamin C. The test revealed the presence of vitamin C in unsuspected sources, and the results have been proved accurate by subsequent tests on animals. The adrenal cortex appears to be three times and the adrenal medulla twice as potent as lemon juice; the kidney, the lens of the eye and the aqueous humor also show considerable vitamin C.

Müller and his co-workers[62] found 20 mg. of vitamin C per hundred cubic centimeters in the aqueous humor and from 30 to 40 mg. per hundred cubic centimeters in the lens of the cow. In aphakic eyes and eyes with cataracts, the content of vitamin C of the aqueous humor was low. The investigators noted that the amount of vitamin C in the lens and in the aqueous humor varied with the age and the species of animal. In cattle, vitamin C was detected in the vitreous humor, ciliary body, iris, retina and cornea, but in very minute quantities in the last-mentioned structure. Regenerated aqueous humor following operative procedure contained less vitamin C than the normal aqueous humor.

Activity of Vitamin C.—Harris and his co-workers regarded cevitamic acid as a promoter of the oxidative or respiratory system in the tissues. It is to be expected that lack of this acid in the tissues will result in diminished oxidative activity. Birch and Dann[63] described cevitamic acid and glutathione as linked factors in one system of oxidation in the animal cell. On the other hand, when vitamin C is deficient in the diet, as in cases of scurvy, the capillaries of the vascular bed are involved. Hess and Fish[64] introduced a test for capillary resistance in order to determine the ability of the small blood vessels to withstand increased intravascular pressure. They found the test valuable in detect-

61. Birch, T. W.; Harris, L. J., and Ray, S. N.: Biochem. J. **27**:590, 1933.

62. Müller, H. K.; Buschke, W.; Gurewitsch, A., and Brühl, F.: Klin. Wchnschr. **13**:20 (Jan. 6) 1934.

63. Birch, T. W., and Dann, W. J.: Nature, London **131**:469, 1933.

64. Hess, A. F., and Fish, M.: Infantile Scurvy: The Blood, the Blood Vessels and the Diet, Am. J. Dis. Child. **8**:386 (Dec.) 1914.

ing early cases of scurvy. Wolbach and Howe [65] showed that the defect in the capillaries results from failure of the endothelial cells to form cement substances, and they concluded that the essential pathologic alteration in scurvy is "an inability of the supporting tissue to produce and maintain intercellular substances."

Comment.—Synthetic vitamin C, called ascorbic acid, has been found helpful in the treatment of certain types of hemophilia, hemorrhagic nephritis, pyorrhea and several other diseases against which medicine was helpless.[66] This result is the more striking since these pathologic conditions have not been thought associated with the lack of vitamin C. It is predicted that the rôle of cevitamic acid in the maintenance of life may be found to be even more important than is now realized, for there seems to be no cellular life in higher organisms without this acid. The ophthalmologist would do well to try this therapy in many types of hemorrhagic retinitis and hemorrhages in the vitreous in which the etiology is unknown. The reports of Birch and Dann and Müller and his co-workers indicate that vitamin C is necessary for ocular metabolism. The close association between glutathione and cevitamic acid is interesting, for Müller showed that there is less vitamin C in the mature cataract than in the normal lens. Adams [67] observed that in hypermature and in old traumatic cataracts in man both glutathione and the thermostable reduction system were absent from the lens. Is it not possible that vitamin C may have a part in the formation of cataract, particularly when it is absent in the pabulum of the eye? This idea is worth investigating.

VITAMIN E

Evans and Bishop [68] found it necessary to include in the diet a fat-soluble substance which they called vitamin E in order to procure a normal estrual cycle in the rat. With vitamin E the animal had gestation and produced a healthy litter. When vitamin E was omitted from the diet, the seminiferous epithelial cells (germinal cells) completely degenerated. In the female no degeneration of ova was demonstrated, but following normal gestation the fetus died. The secret underlying the vital need for vitamin E on the part of certain tissues, e. g., the testicular epithelium and the developing embryo, has not been penetrated (Evans, 1932). It is especially interesting that the germinal cells of the male exhibit this need but that those of the female do not. As yet vitamin E has not found a place in ophthalmologic treatment. On the many

65. Wolbach, S. B., and Howe, P. R.: Arch. Path. **1**:1 (Jan.) 1926.

66. Synthetic Vitamin C, Science (supp.) **80**:6, 1934.

67. Adams, D. R.: Brit. J. Ophth. **14**:49, 1930.

68. Evans, H. M., and Bishop, K. S.: J. Metab. Research **1**:319 (Feb.) 1922.

experiments that have been performed, no report has been made of ocular disturbances accompanying a deficiency in vitamin E. Time will tell whether it is necessary for the health of the ocular tissue.

GENERAL REVIEW

Knowledge of vitamin therapy should be of great importance to the clinical ophthalmologist. The investigator has pointed out that animals deprived of this supplement in the diet suffer from some form of ocular disturbance; likewise, an excess of vitamins may produce ocular disturbance. Much disagreement among clinicians with respect to vitamin therapy is doubtless due to failure to appreciate the fact that many of the studies conducted on animals are not comparable to those made on man. Every clinician knows that a dietary deficiency in man is much more likely to be a complicated condition. It is obvious that when clearcut results are obtained in suitably controlled experiments on animals they deserve careful consideration. It is gratifying to see how rapidly ocular manifestations which have as their underlying cause focal infections or a lowered general condition improve when the therapy includes foods high in vitamins in addition to the regular diet. In the last six years in this clinic my associates and I have made use of the experimental findings derived from our investigations on animals.

In sickness or in convalescence special efforts should be made to supply a diet complete in all essentials. Indeed, too little attention has been given in the past to the consideration of the relation of diet and disease. There are times when special demands are made on metabolism; for instance, it has been observed that deficiency diseases, such as beriberi and scurvy, are more rapidly contracted by men engaged in hard manual exercise than by those receiving the same diet who are not so engaged. Pregnancy and lactation in women and growth in children also call for a larger supply of the vitamins.

The fact that outspoken deficiency diseases are almost unknown in this country has occasioned much skepticism in the minds of some persons as to the importance of vitamins in the human diet. It is true that the average diet includes a large variety of foods, so that a deficient intake of a particular food factor appears improbable; this conclusion may, however, be misleading. In the first place, it does not take into account the times and circumstances; secondly, it fails in the realization that what formerly was regarded as an excellent mixed diet may in reality be defective. It is now becoming generally recognized that much subnormal health and development and even the incidence of disease are associated with a partial deficiency of one or more of the accessory substances.

News and Notes

EDITED BY DR. JOHN HERBERT WAITE

SOCIETY NOTES

British Medical Association.—The annual meeting of the British Medical Association will be held at Melbourne. The program in ophthalmology is as follows:

Thursday, September 12

At 10 a. m. there will be a discussion on "Glaucoma, with Special Reference to Medical Aspects and Early Diagnosis." Mr. H. M. Traquair (Edinburgh) will open the discussion. In the afternoon there will be a demonstration on fusion training by Dr. T. a'B. Travers (Melbourne), with a discussion.

Friday, September 13

At 10 a. m. there will be a discussion on "Cyclitis." The discussion will be opened by Mr. J. H. Doggart (London). The afternoon will be devoted to operations.

All-India Ophthalmological Society.—The fourth conference of the All-India Ophthalmological Society was held at Madras at the end of April under the presidency of Lieut.-Col. R. E. Wright, professor of ophthalmology and superintendent of the Government Ophthalmic Hospital, Madras. Keratomalacia or xerophthalmia as a common cause of preventable blindness was one of the chief topics of discussion. Twenty patients showing the various manifestations of the disease were presented. The subject of greatest interest was primary noncongestive glaucoma, with particular reference to the recent outbreaks of epidemic dropsy in Calcutta. Hundreds of operations for decompression by sclerocorneal trephining have been performed in Calcutta during the past few months.

New England Ophthalmological Society.—The New England Ophthalmological Society was entertained at Portland, Maine, on Saturday, June 29, by members residing in Maine and New Hampshire. The day session was given to tennis, golf and fishing, and the evening session was addressed by Dr. John Dunnington of New York, who spoke on the treatment of strabismus.

Virginia Society of Oto-Laryngology and Ophthalmology.—Dr. Emory Hill, of Richmond, was recently elected president of the Virginia Society of Oto-Laryngology and Ophthalmology at its sixteenth annual meeting, in Fredericksburg. Other officers are: Dr. Joseph Minor Holloway, Fredericksburg, vice president, and Dr. George G. Hankins, Newport News, secretary, reelected. The next meeting will be held in Richmond in May 1936.

GENERAL NEWS

Preventive Ophthalmology.—In an effort to prevent loss of sight from fireworks accidents, the American Museum of Safety of New

York City has planned a survey of Fourth of July accidents under the direction of Dr. Leland E. Cofer with the aid of the following committee: Dr. Donald B. Armstrong, vice president, Metropolitan Life Insurance Co.; Mr. Lewis H. Carris, managing director, National Society for the Prevention of Blindness; Mr. C. H. Fleming, executive secretary, Pyrotechnic Industries, Inc.; Mr. James L. Fry, managing director, Toy Manufacturers of the United States of America; Mr. Lee F. Hanmer, director, recreation department, Russell Sage Foundation; Mr. Albert S. Regula, secretary, American Museum of Safety; Mr. Louis Resnick, director of industrial relations, National Society for the Prevention of Blindness; Mr. James Speyer, treasurer, American Museum of Safety; Mr. W. S. Topping, assistant chief inspector, United States Bureau of Explosives; Mr. Franklin H. Wentworth, managing director, National Fire Protection Association.

American Board of Ophthalmology.—The American Board of Ophthalmology will hold an examination for certification in Cincinnati on September 17. All applications must be filed before July 15 with the Secretary, Dr. William H. Wilder, 122 South Michigan Avenue, Chicago.

UNIVERSITY NOTES

Dr. Arthur James Ballantyne, lecturer in ophthalmology in Glasgow University, has recently been appointed to the new Tennent chair of ophthalmology. Dr. Ballantyne has been ophthalmic surgeon to the Glasgow Eye Infirmary and consulting ophthalmic surgeon to the Western Infirmary and Glasgow Royal Maternity Hospital since 1909. He will preside as president of the section of ophthalmology at the annual meeting of the British Medical Association at Melbourne in September.

Summer Course in Ophthalmology, University of Rochester.—The sixth annual summer course in ophthalmology at the University of Rochester will be held July 29 to August 2. The enrolment will be limited to fifty. The following subjects will be discussed: ophthalmic surgery, medical ophthalmology, perimetry and ophthalmic neurology, slit-lamp microscopy, pathology, refraction and the ocular muscles. The guest lecturers will be Dr. William H. Wilmer, Dr. Alan C. Woods, Dr. Sanford R. Gifford, Dr. Walter I. Lillie, Dr. Meyer Wiener, Dr. Manuel U. Troncoso and Dr. Alfred Cowan. For complete information about the course, address Dr. John P. Gipner, Rochester, N. Y.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

THE RETICULO-ENDOTHELIAL SYSTEM OF THE EYE. MORARD, Arch. d'opht. **51**: 583 (Sept.) 1934.

In the first part of this paper the important rôle which the reticulo-endothelial system plays as a defense mechanism is pointed out and the literature as it relates to the eye is reviewed. In the second part a systematic description of this system as it occurs in the eye is presented. The significance of the system is suggested from both an experimental and a clinical point of view.

S. B. MARLOW.

Aqueous Humor

TWO CRYSTALS IN THE ANTERIOR CHAMBER. H. LONGUET, Bull. Soc. d'opht. de Paris, March 1934, p. 183.

An infant had been struck in the right eye by a fragment of exploded shell which was never localized. Later a spontaneous hemorrhage into the anterior chamber occurred. When the hemorrhage began to clear, it was noted that two small refractile crystals were lying in the anterior chamber on the framework of the blood clot, which was being absorbed. The eye was enucleated to prevent sympathetic ophthalmia.

L. L. MAYER.

Biochemistry

LACTIC ACID CONTENT OF THE BLOOD IN PATIENTS WITH SENILE CATARACT. H. VIALLEFONT, D. DULCY and L. DIACONO, Arch. Soc. d. sc. méd. et biol. de Montpellier **15**: 525, 1934.

The lactic acid content of the blood augments with age. In cases of senile cataract specimens collected before breakfast averaged 28 mg. per hundred cubic centimeters as contrasted with the average normal amount of 22 mg. for the same age period.

J. E. LEBENSOHN.

Conjunctiva

GRANULOMA OF THE BULBAR CONJUNCTIVA WITH ADENOPATHY: TWO OBSERVATIONS. VALIÈRE-VIALEIX, Ann. d'ocul. **171**: 808 (Oct.) 1934.

Recent communications by Morax drew attention to granulomatous lesions of the conjunctiva accompanied by extensive adenopathy. Vialeix adds two observations which occurred almost simultaneously. The following symptoms constituted a clinical syndrome which he believes is characteristic: (1) a lesion of the limbus of the conjunctiva of nodular or granulomatous type associated with acute conjunctival symptoms and accompanied by yellowish granulations of the inferior culdesac in one case, and by a common follicular appearance in the other; (2) an extensive submaxillary and preauricular adenopathy.

S. H. MCKEE.

PLASMOCYTOMA OF THE CONJUNCTIVA. L. TAJKEF, Ann. d'ocul. 171: 934 (Nov.) 1934.

Plasmocytoma of the conjunctiva is a rarity, and is still a subject of considerable controversy from both the etiologic and pathologic points of view.

The case reported here was that of Mrs. J. F., aged 60, who enjoyed good health until in 1925 an abscess of the left lower lid appeared. With the application of poultices the abscess discharged and seemed to be cured, but within a few months it recurred at the same place. She was treated during the year 1926 and in the month of September 1927 came under the observation of Tajkef. At that time the whole of the left lower lid was swollen and everted, with a fungus-like yellowish material filling the culdesac and extending onto the bulbar conjunctiva. The superior palpebral conjunctiva, too, was thickened, inflamed and granulous. The cornea and lens were transparent; the movement of the globe was free.

Medical treatment was without effect, so the patient was admitted to the hospital, and a biopsy was done. The histologic details of the examination are given. The diagnosis was infiltration of the conjunctiva by lymphoid and plasma cell tissue.

S. H. MCKEE.

ARGYROSIS OF THE CONJUNCTIVA: BIOMICROSCOPIC EXAMINATION. H. VILLARD and C. DÉJEAN, Arch. Soc. d. sc. méd. et biol. de Montpellier 15: 297, 1934.

The topography of argyrosis of the conjunctiva is determined by two factors: gravity and the wrinkling of the conjunctiva. The inferior culdesac is hence especially affected, and only the elevations of the rugose mucous membrane become pigmented. Suitable traction will reveal clear streaks and islands that correspond precisely to infolded areas of conjunctiva. High magnification further shows that the pigment is distributed in mosaics of very irregular stippling, bearing certainly no relation to the vascular distribution. The granules of pigment seem to be contained in the external portion of the epithelial cells, and lie also along the basement membrane.

The distribution of argyrosis demonstrates how irregular the action of medicaments in the conjunctival sac must generally be. Massage after instillation is recommended to facilitate penetration, which probably would also be favored by the incorporation of drugs in fluids the viscosity and surface tension of which are low.

J. E. LEBENSOHN.

TWO OBSERVATIONS OF GRANULOMA OF THE BULBAR CONJUNCTIVA ASSOCIATED WITH ADENOPATHY. VALIÈRE-VIALEIX, Bull. Soc. d'opht. de Paris, July 1934, p. 361.

The two cases are comparable to those reported by Morax. A girl of 12 years had noted redness and tearing of the right eye for three weeks. The lids were stuck together on the patient's awakening. About one week after the onset of the condition the preauricular and submaxillary glands were swollen. The conjunctiva of the lids and the culdesac were edematous and had a velvety consistency. On the bulbar conjunctiva near the nasal limbus, there was a zone, from 3 to 4 mm.

in width, where a "heaping up" occurred. This nodule was slate-gray and ulcerated, and stained with fluorescein. Other small gray granulations occurred in the inferior culdesac. The swollen glands were painful on pressure. Though the condition was suspected of being tuberculous, all tests for tuberculosis were negative. Periadenitis with fluctuation occurred. On incision of the gland only blood was obtained.

The second patient, aged 9 years, had acute conjunctivitis for one week. Then on the bulbar conjunctiva, near the external limbus, appeared a small slate-colored lesion. Two days later, adenopathy was manifest. All tests to clinch the diagnosis of tuberculosis were negative. In from three to four weeks the symptoms subsided. In these cases biopsies of material from the lesions showed only granulation tissue. The suggestion has been offered that the condition is related to an impetiginous disease. The author doubts this hypothesis but does not offer any substitute.

L. L. MAYER.

Congenital Anomalies

TOOTH IN A LID AND PALPEBRAL COLOBOMA. VAN DER STRAETEN and APPELMANS, Arch. d'opht. **51**: 417 (July) 1934.

In a boy, 5 years old, a tumor was found in the inner third of the right lower lid. At birth two teeth were present in the gums corresponding to the canine and lateral incisor on the right side. These were lost at the age of 3 weeks. The tumor of the lid was removed. Histologic examination showed it to be an uncalcified but perfectly formed tooth. There was no evidence that the tumor was a dermoid. This case is of interest because of the coincidental occurrence of a coloboma of the lid in which a tooth was found. The authors point out that coloboma of the lid is the least rare of the congenital malformations present in this case. It more commonly involves the upper lid. When the lower lid is affected, the defect occurs in the inner third and is frequently accompanied by other malformations such as dermoid of the cornea. In order to explain the presence of a tooth in the lower lid they call attention to the derivation of the lower lid from the first branchial cleft. They also call attention to the review of the whole subject by van Duyse in the "Encyclopédie française d'ophtalmologie."

S. B. MARLOW.

A RARE FORM OF PERSISTENT PUPILLARY MEMBRANE WITH MICROPHTHALMOS. F. F. COSMETTATOS, Arch. d'opht **51**: 532 (Aug.) 1934.

A case is described of a microphthalmic eye in which the pupil was blocked by a cone-shaped brownish membrane attached to the pupillary margin of the iris throughout its whole circumference. This cone extended to the posterior surface of the cornea, where some fine pigment was noted. It seemed to be attached to the endothelium. An unsuccessful attempt was made to remove the membrane in toto. After a piece had been excised, the lens behind was found to be cataractous. Histologic examination of the excised portion confirmed the clinical diagnosis of persistent pupillary membrane. Cases in which a persistent pupillary membrane is attached to the pupillary margin of the iris are rare. Cosmettatos refers briefly to those which have been described in the literature and offers an explanation for the occurrence of this form.

S. B. MARLOW.

Cornea and Sclera

THE CORNEAL PIGMENT IN HEPATOLENTICULAR DEGENERATION (THE KAYSER-FLEISCHER RING). W. ROHRSCHNEIDER, Arch. f. Augenh. **108:** 391, 1934.

It has been apparent for some time that the pigment in the cornea forming the Kayser-Fleischer ring changes its property after being immersed in fixing fluids (solution of formaldehyde, alcohol). Other authors have reported a disappearance of the pigment after the tissue had remained nine months in alcohol and solution of formaldehyde, and in a case observed by Jess (Jess, A.; *Klin. Monatsbl. f. Augenh.* **79:** 145, 1927) the pigment could not be demonstrated after the eye had been embedded in pyroxylin (celloidin). In Rohrschneider's own case, after the eye had been in solution of formaldehyde for one year the pigment could not be bleached with hydrogen dioxide and was no longer soluble in potassium hydroxide and ammonia, although previous to fixation such reactions were positive.

It seems probable that the basis of the pigment is not silver. The experiments reported seem to prove that lipofuscin and urobilin are not present. There is certainly a similarity of this pigment to that found in malaria, and it is still probable, as Fleischer pointed out twenty years ago, that the pigment is a derivative of hemoglobin. F. H. ADLER.

Experimental Pathology

EXPERIMENTAL INOCULATION OF CATERPILLAR HAIRS. C. DÉJEAN and H. HARANT, Arch. Soc. d sc. méd. et biol. de Montpellier **15:** 539, 1934.

Living pine caterpillars were placed in the superior culdesacs of rabbits' eyes for five minutes. Typical ophthalmia nodosa developed shortly with free secretion, swelling of the lids, development of opaline nodules in the tumescent conjunctiva and opacification of the cornea, in which the slit lamp revealed caterpillar hairs penetrating deeply. The inflammatory process was less intense than in man. Within four weeks there remained but slight traces of irritation, whereas in man the disorder continues for months.

The dominant pathologic changes in tissue removed at various intervals were: (1) five days after inoculation, a lymphocytic reaction; (2) a week later, numerous macrophages (histiocytes) with giant cells about clefts left by the disappearing hairs (in man the penetrating hairs tend to persist); (3) in the next two to five weeks, a terminal cicatricial phase with proliferation of the fibroblasts and fixed cells of the conjunctiva. J. E. LEBENSOHN.

General

OPHTHALMOSCOPIC OBSERVATIONS IN ONE HUNDRED AND ONE CASES OF CHRONIC OPIUM POISONING. A. MOTEGI and S. SYÚ, Klin. Monatsbl. f. Augenh. **93:** 367 (Sept.) 1934.

Motegi and Syú gave a detailed report of their observations on 101 patients suffering from chronic opium poisoning. The patients were examined on admission to the hospital, after recovery and when leaving the hospital. Such patients are put into the hospital by law. The

average time for the cure is one month. About 17,468 patients were cured in the province of Taiwan alone within three years; all of them were Chinese. Almost 60 per cent of the 101 patients showed ocular diseases of various types. The following changes were attributed to opium poisoning: anemia of the disk (in most cases transient) as the result of changes in the composition of the blood but not of anatomic changes, and contraction of the palpebral fissure (73.17 per cent), miosis (about 83 per cent), enophthalmos (41 per cent) and decreased tension (84.62 per cent), all supposed to be caused by a lesion of the sympathetic nervous system. The reduction of the distance of the near point, found in 85 per cent of the patients, is explained as an irritation of the parasympathicus.

K. L. STOLL.

General Diseases

THE RIDDLE OF TUBERCULOSIS: OBSERVATIONS ON THE LOCALIZATION OF DISSEMINATED HEMATOGENOUS FOCI AND ON PSYCHONEUROTIC "PRETUBERCULOUS CONDITIONS"; REPORT OF CASES. WILHELM NEUMANN, Klin. Monatsbl. f. Augenh. **93**: 300 (Sept.) 1934.

Following an etiologic explanation of general miliary tuberculosis, Neumann discusses, in detail, miliary tuberculosis localized in certain parts of the body and in certain tissues. He accepts A. Sternberg's division into four groups:

1. Metastases in the entoderm, especially in the lungs, larynx and intestines.

2. Metastases in the ectoderm, especially in the skin and eyes, developing immediately after puberty, in the presence of practically absolute resistance to pulmonary tuberculosis. One type of this group is characterized by its association with enlargement of the spleen and by a tuberculous structure of the metastases, e. g., nodular iritis, tuberculous iridocyclitis and choroidal tubercles. The second type is associated with a normal condition of the spleen, and there is no tuberculous aspect of the metastases; so-called "rheumatoid" episcleritis and some forms of chronic iritis, iridocyclitis and choroiditis belong to this type. Pulmonary changes are absent or slightly marked. The cases of parenchymatous keratitis in children with congenital syphilis described by Wessely and cases in which avirulent tubercle bacilli are present pertain to this class. Invasion by spirochetes furnishes no sufficient proof, according to Wessely. The experiments on anaphylactic keratitis by Wessely, von Szily and Köllner are referred to in this connection; also Riehm's research on elective sensibilization and certain cures with Arima's A-O treatment.

3. Metastases in the mesenchyme with tuberculosis miliaris discreta which may change to the ulcerofibrous form, and with tuberculosis near the epiphyses, leading to tuberculosis of the joints. Adults may suffer from involvement of the serous linings and from ocular "rheumatism"; the spleen is normal.

4. Metastases in the mesoderm. These arise in the growing genitourinary system about the time of puberty; frequently the findings are complicated with hematogenous or ulcerofibrous tuberculosis.

Aside from these instances of a coordination of tuberculous metastases, another phenomenon is discussed: An organ once affected

by tubercle bacilli by way of the blood seems to invite later attacks by tubercle bacilli. It may be termed, according to Rollier, a surgical focus of tuberculosis, which acts as a center of immunization for the organism. Abscesses of this kind, in containing tubercle bacilli or mutatis mutandis, pneumococci or typhus bacilli, prevent them, so to speak, from flooding the blood. A third phenomenon is the invasion of organs symmetrically, e. g., both kidneys in Addison's disease, while tubercle bacilli are found in no other organ of the body except a few glands. Recent research on sympathetic ophthalmia by Meller showed tubercle bacilli in the sympathizing eye. Vaccination with dried substance of the spinal cord occasionally produced paresis of both legs, based on bacteria-free myelitis.

Beginning the second chapter of his paper, Neumann refers to the fact that closed tuberculous foci are more apt to produce general miliary tuberculosis when they give rise to dispersion of the bacilli in the blood than foci which are open. He referred to foci in the bronchi, the intestines and the bladder. The strongly toxic effect of closed foci is evident, furthermore, in psychoneurotic conditions and more or less severe psychic disorders. The disturbances disappear as soon as the foci open. Seven examples are reported. To this class belong severe tuberculotoxic headaches, which frequently appear after pleuritic or peritoneal tuberculous abscesses and which accompany choroidal tubercles.

In conclusion, Neumann refers to hyperthyreotoxic symptoms developing at the onset of tuberculous dispersion (*Streuung*) prior to the development of open pulmonary tuberculosis. In some instances these symptoms resemble those of exophthalmic goiter. Pluriglandular atrophy following febrile closed tuberculosis belongs in this category.

K. L. Stoll.

Fundus Changes in Latent Syphilis. Sahegi, Acta soc. ophth. jap. **38:** 79 (June) 1934.

Sahegi believes that congenital syphilis, particularly latent syphilis, runs an identical course. Under certain conditions the four types of congenital syphilis can be seen in acquired syphilis. During the past ten years since the discovery of neoarsphenamine, syphilis has changed its form, and is undoubtedly becoming milder and invisible. This has often been expressed by statements that syphilis has been driven inward. Possibly fundus changes have been overlooked. It would be interesting to see whether ocular syphilis has changed its form. In a certain number of cases the Wassermann reaction remains fast. The fundus changes are insidious; there is little diminution in vision and subjective symptoms are absent. The retinal opacity is like a veil which can hardly be recognized. After a number of months the opacity clears up and later the "pepper and salt" fundus is seen. A. Knapp.

General Pathology

Bridges of the Sella Turcica. K. Velhagen Jr., Arch. f. Augenh. **108:** 559, 1934.

In certain cases, atrophy of the optic nerve, especially that thought to be due to a form of glaucoma without demonstrable rise in tension,

has recently been described in the literature as due to certain variations in the bones of the skull. The bony bridges which are occasionally found over the sella are a type of such changes. In order to determine their frequency among persons who show no optic nerve changes, Velhagen examined the skulls in the anatomic museum and x-ray films of skulls taken in the pediatric service of the hospital. Children's skulls were selected in order to avoid the changes due to senile calcification. He found that as high as 10 per cent of the skulls showed these bridges and concludes from this that they probably have little pathologic significance and are merely coincidental findings in the cases of "pseudo-glaucoma."

F. H. ADLER.

Glaucoma

INTERNAL FISTULATION BY SCLEROCILIARY IRIDENCLEISIS IN GLAUCOMA. A. DEL BARRIO, Ann. d'ocul. **171**: 977, 1934.

The objections to sclero-iridectomy, because of the late infection estimated to occur in 5.5 per cent of the cases, has prompted del Barrio to offer the operation named in the title as a substitute. The iridencleisis of Holth is open to the same criticism. Cyclodialysis would be the ideal operation if the results were permanent, but they rarely are. Internal iridencleisis corrects the deficiency of cyclodialysis and establishes a permanent communication between the anterior chamber and the suprachoroidal space, converting this into one channel covered with epithelium.

The technic is easy and consequently the operation may be performed by all. It is devoid of all primary or secondary complications and is of more value than sclero-iridectomy. It is indicated in all types of glaucoma. Even in acute glaucoma, although del Barrio has not performed it in any cases of this type, it is absolutely without danger and may be attended with even less risk than simple iridectomy. He believes the technic which he describes is easier and more efficacious than that of Mauksch.

In the present state of surgical therapeutics for glaucoma, one should not use the older methods of operation unless iridencleisis has failed.

There are five illustrations and an extensive bibliography.

S. H. MCKEE.

A RARE CASE OF CONGENITAL HYDROPHTHALMOS. A. A. BIELSKY, Sovet. vestnik oftal. **5**: 579, 1934.

A child, aged 2½ years, had typical bilateral hydrophthalmos. The unusual feature was the periodic spontaneous dislocations of the lenses into the anterior chambers and their disappearance within from several hours to two days. The luxations sometimes occurred alternately and sometimes simultaneously. The dislocated lens was always located at or a little below the pupil, but never did it sink to the bottom of the anterior chamber. It seemed as if the lens was attached posteriorly (to hyaloid membrane ?). It was impossible to produce the dislocation of the lens artificially. The possible explanation Bielsky gives is that the increase of the intra-ocular tension pushed the lens forward; when,

owing to some changes in the endocrine vegetative apparatus, the tension decreased the lens was drawn back into the posterior chamber. Miotics did not change the condition.

O. SITCHEVSKA.

THE PRESENCE OF SUBSTANCES IN THE BLOOD SERUMS OF GLAUCOMATOUS PATIENTS WHICH STIMULATE SMOOTH MUSCLE TISSUE. IWATA, Acta soc. ophth. jap. **38**: 66 (June) 1934.

In a previous article, Iwata showed that the blood serum of a patient with glaucoma, particularly during an attack, will cause the duodenal tissue of a rabbit to contract more than it will when treated with normal human serum. The action seems to be due to a direct effect on the muscular tissue. He has continued the experiments and has found that in some cases of glaucoma, not only during the attack but during the intervals, the action of epinephrine is not increased by the addition of serum. He therefore thinks that there are biologic processes at work similar to those in the serums of persons with hypothyroidism as represented by the enormous increase of the blood amino-acids. The biologic action of the serums of patients with retinitis pigmentosa and retinitis albuminurica shows no unusual features. There is no increase in stimulation of the smooth muscle fibers. Examinations of the urine of glaucomatous patients gave disappointing results, though there seemed to be a tendency to show a certain stimulating action on smooth muscle fibers.

A. KNAPP.

Injuries

THREE UNUSUAL CASES OF FOREIGN BODIES IN AND ABOUT THE EYEBALL. F. T. TOOKE, Brit. J. Ophth. **18**: 695 (Dec.) 1934.

CASE 1.—The patient was a man aged 52. Eight years previously, while striking a concrete pipe with a steel hammer, he felt something fly into his eye. Sight was lost almost immediately. X-ray plates were negative. When the eye was examined by Tooke, there was an iritis with precipitates on Descemet's membrane. The lens was cataractous. A crescentic foreign body could be seen free in the anterior chamber, though examination of an x-ray plate yielded negative results. The foreign body proved nonmagnetic. It was removed by forceps. Subsequently the eye was enucleated.

CASE 2.—A man 32 years of age stated that three months previously a small lump had appeared over the right upper lid. It was noninflammatory and progressive. Roentgen examination showed a narrow bandlike shadow thrown from the margin of the orbit in the direction of the apex of the orbit. Two long wooden splinters were found occupying a cystic cavity which extended backward into the orbit. The splinters were 35 cm. in length and were encapsulated.

CASE 3.—A man aged 51 stated that the left eye had annoyed him from time to time for many years. There was ciliary injection. There was no evidence of a wound of the cornea. The posterior surface of the cornea was beclouded by lymph. The iris was inflamed, but there was no posterior synechia visible. Attached to the iris between the pupil and the angle of the chamber was a mass 1 by 2 mm. in dimensions. The biomicroscope showed it to have a pearl gray color

at its center, but elsewhere it was melanotic in appearance. The x-ray plates showed a foreign body shadow in the mass. On withdrawing the iris through a corneal incision a small pebble fell out. The patient recalled that thirteen years before, the eye was injured while he was harvesting potatoes.

Elements of fallacy arose in each of the three cases. In case 1 the x-ray plate failed to show a large piece of concrete, while in case 3 the x-ray plate revealed a very much smaller foreign body. The biomicroscope overpainted the picture in case 3, while it contributed some information in case 1.

The article is illustrated.

W. ZENTMAYER.

DOUBLE PERFORATION OF THE EYEBALL WITH PRESERVATION OF NORMAL VISION. N. TARADINA, Sovet. vestnik oftal. **5:** 396, 1934.

Taradina reports three cases of double perforation of the eyeball seen with the ophthalmoscope. In two cases, the roentgenogram showed the foreign body to be located in the upper temporal angle of the orbit. The electromagnet gave negative results. The entrance wound was at the sclera, 4 to 5 mm. below and lateral to the limbus; ophthalmoscopic examination showed a rent of the retina and choroid above the disk—the site of secondary perforation. The cornea and lens were transparent. No iridocyclitis resulted despite the fact that the foreign body perforated the sclera at the edge of the ciliary body. The tear in the retina closed up, and vision was 20/20 in the injured eye with correction in a few weeks after the injury. In the third patient there was a mild iridocyclitis; the x-ray photograph revealed a foreign body in the upper inner angle of the orbit. The electromagnet gave the feeling of a slight tension of the eye, without pain following. The vision was 6/10 in the injured eye. No operation was attempted in any of these cases because of absence of irritation of the eyeball. Taradina believes that the prognosis in double perforations produced by small foreign bodies is rather good because the injury produced in the tissues of the eyeball is mild.

O. SITCHEVSKA.

Lacrimal Apparatus

THE EMPLOYMENT OF ABLATION OF THE SAC, OF STRICTUROTOMY AND OF DACRYOCYSTORHINOSTOMY IN DISORDERS OF THE LACRIMAL PASSAGES. N. BASTAN, Ann. d'ocul. **171:** 846 (Oct.) 1934.

In a patient presenting atresia of the lacrimal canal, simple or complicated by dacryocystitis, pericystitis, etc., there is one important question to consider, namely, whether the seat of the constriction is above or below the sac.

In the first case one proceeds to remove the sac; in the second, stricturotomy is the procedure of choice, and it is only when at a loss what to do that one should have recourse to plastic dacryocystotomy; if the last is chosen, removal of the sac is necessary.

It is to be noted that in the majority of cases in which stricturotomy is chosen, if the cause is shown to be a bony lesion only, the chances are that the tissues will be found to be considerably altered, and the suc-

cess of a plastic dacryocystorhinostomy will be to some extent hindered. In such a case it is better to proceed with removal of the sac.

There are four illustrations. S. H. McKee.

Effect of Artificial Fever on the Lacrimal Elimination of Sodium Chloride. D. Michail and P. Vancea, Compt. rend. Soc. de biol. **117**: 1273, 1934.

In ten persons fever was induced by intramuscular injections of milk. The salt content of the lacrimal fluid regularly rose with increasing temperature, reached its maximum at the height of the fever, and continued above its normal value for twenty-four hours thereafter. Since the fever induces a diminished concentration of sodium chloride in the blood plasma, the increased elimination of salt in the tears appears to result from definite stimulation. J. E. Lebensohn.

Lens

Two Cases of Zonular Cataract. H. Longuet, Bull. Soc. d'opht. de Paris, March 1934, p. 181.

Longuet performed an iridectomy in a patient who had bilateral zonular cataract. Three days after the operation the anterior chamber had not reformed, and a space was found between the posterior corneal surface and the iris which communicated with the subconjunctival space. The same day the anterior chamber reformed. A second patient showed the zonular cataract in one eye only. The opacity took the form of a concave cupola turned toward the iris. The differences in these two types of zonular cataracts are the reason for the report.

L. L. Mayer.

Subconjunctival Extraction of Cataract. C. Sanguinetti, Lettura oftal. **11**: 22 (Jan.) 1934.

Sanguinetti reviews previous methods of employing the conjunctival flap and describes a new one. Lateral vertical incisions in the conjunctiva at the sites of puncture and counterpuncture facilitate an incision with a large bridge conjunctival flap made with the knife, under which the lens is extracted. S. R. Gifford.

Cholesteremia and Cataract. C. Galeazzi, Rassegna ital. d'ottal. **3**: 199 (March-April) 1934.

Taking as his starting point the classic researches of de Lieto Vollaro on a "morphologic syndrome of cholesterol steatosis in the normal senile eye," Galeazzi carried out quantitative determinations of blood cholesterol in forty-five patients with cataract and obtained a medium value which almost corresponds to the normal figure (0.177 per cent). He discusses this finding and concludes in favor of the possibility expressed by de Lieto Vollaro, that senile cataract is due to exaggeration of a physiologic process, represented by an infiltration of cholesterol esters into the senile lens in the presence either of a normal or of an excessive amount of cholesterol in the blood. This may take

place as a result of an altered permeability of the capsule of the lens and of a decreased power of selectivity on the part of the capsular epithelium.

V. R. SYRACUSE.

AMOUNTS OF VITAMIN C IN THE LENS, AQUEOUS AND BLOOD IN NORMAL AND PATHOLOGIC LENS METABOLISM. H. K. MÜLLER and W. BUSCHKE, Arch. f. Augenh. **108**: 368, 1934.

In previous experiments H. K. Müller (*Ztschr. f. deutsch. ophth. Gesellsch.* **49**: 168, 1932; *Schweiz. med. Wchnschr.* **63**: 1033, 1933; *Arch. f. Augenh.* **108**: 41, 1933; *Nature,* London **132**: 280, 1933) showed the presence of a reducing substance in the aqueous which apparently had its origin in the normal crystalline lens, for only traces of it could be found in aphakic eyes or in experimentally produced cataracts. Further studies showed that this substance formed a typical oxidation-reduction system, and its physicochemical properties suggested that it was ascorbic acid, i. e., vitamin C.

In the work on which the present paper is based, the vitamin C content of the aqueous, lens, vitreous, ciliary body, cerebrospinal fluid and blood of the commoner laboratory animals was determined; also that of the lens, aqueous and blood of man. The methods are given in full.

The aqueous and the lens of most of the experimental animals contained large quantities of vitamin C. The other parts of the eye contained lesser amounts. The individual species of animals, however, showed large variations in the vitamin C content of the lens. In rabbits there was a considerable diminution in the amount of vitamin C with increasing age. This was even more striking than the reduction in the amount of glutathione which had previously been shown to occur with increasing age.

The authors believe that the lens gives up large amounts of vitamin C to the aqueous, for it does not occur in such quantities in aphakic eyes or in the blood or in the cerebrospinal fluid. In senile cataract and complicated cataracts of cattle much less vitamin C was present, and this reduction was often associated with a reduction in the amount of vitamin C in the aqueous. In rabbits' lenses which had become cataractous through poisoning with naphthalene there was less vitamin C.

F. H. ADLER.

THE VITAMIN C CONTENT OF THE LENS AND AQUEOUS IN CATTLE OF DIFFERENT AGES AND IN PERSONS WITH CATARACT. A. GUREWITSCH, Arch. f. Augenh. **108**: 572, 1934.

Gurewitsch points out the variations in reports on the vitamin C content of the tissues, which is perhaps due to the lack of specificity of the test. He repeats the work of others on the content of vitamin C in the lenses of cattle of various ages, and finds that the percentage of vitamin C falls with age. In addition to this, there is less vitamin C in the nucleus than in the cortex of the normal lens. In a few cases of cataract, the vitamin C content was reduced or altogether absent.

F. H. ADLER.

SUNFLOWER CATARACT IN HEPATOLENTICULAR DEGENERATION (PSEUDOSCLEROSIS): REPORT OF A CASE. R. THIEL, Klin. Monatsbl. f. Augenh. **93**: 12 (July) 1934.

A boy, aged 15, had been well up to his twelfth year, when he had several attacks of fainting, with unconsciousness lasting for about ten minutes, and symptoms which aroused suspicion of typhoid fever; these, however, disappeared after ten days. The swelling of the liver and spleen noted at that time persisted. A year later he presented cramps of his right hand and of virtually his whole body, though more in the left side than in the right side, and rigidity of the platysma myoides, pulling the left angle of the mouth extensively to the left side. In the course of the disease, tonic spasms of all the muscles developed, which occurred spontaneously or were instigated by voluntary motion. Besides these extrapyramidal disturbances of motility, a severe lesion of the liver was present, completing the picture of hepatolenticular degeneration, viz., pseudosclerosis. The following ocular symptoms were observed: (1) the Kayser-Fleischer pigment ring in Descemet's membrane and (2) a faint opacity in the anterior capsule of the lens with short radiating extensions typical of a sunflower cataract. Noticed originally in the presence of copper in the globe only (chalcosis of the lens), sun-flower cataract was found also in pseudosclerosis by Siemerling-Oloff and Vogt. This so-called "apparent cataract," seen only in transillumination, showed a distinct yellowish hue and opalescence, while the radiating extensions, arranged a short distance from the opaque central disk, presented a bluish-green hue. The lens of the right eye was not removed, as the vision of the left eye was normal. No change of the ocular symptoms occurred within one year's observation.

K. L. STOLL.

Lids

BILATERAL CONGENITAL COLOBOMA OF THE UPPER LIDS. BONNET, PAUFIQUE and BONAMOUR, Bull. Soc. d'opht. de Paris, March 1934, p. 229.

Since the first description by Wilde in 1862, reports of about one hundred and fifty cases of this rare condition have been published. The authors' case was complicated by a corneal dermoid and an acute ulceration of the center of the cornea. The dermoid was removed with a Graefe knife and studied histologically. A plastic repair with satisfactory results was accomplished on both upper lids. The case was complicated by a nasal malformation, and this together with the dermoid of the cornea makes the case of unusual interest.

L. L. MAYER.

Methods of Examination

UTILIZATION OF THE BAILLIART METHOD IN EARLY DIAGNOSIS OF INTRACRANIAL HYPERTENSION IN INJURIES OF THE SKULL. A. ARNAUD and P. GUILLOT, Ann. d'ocul. **171**: 735 (Sept.) 1934.

Surgeons are unanimous in recognizing that in certain cases of intracranial hypertension following craniocerebral trauma it is necessary to intervene quickly, either to suppress the cause of the hypertension or

to ameliorate its rapidly disastrous effects. The diagnosis of hypertension is often difficult, especially as the condition is not always easy to establish on clinical grounds.

Logic teaches one to apply to cranial traumas with known hypertension the old methods of ocular exploration applicable to the investigation of the intracranial hypertension that one calls "chronic," as opposed to that which is acute, urgent and immediate. The attention of Arnaud and Guillot was directed entirely to the exploration of the retinal arterial tension. The search for and the proof of a "solitary" cerebral arterial hypertension appear to them as the method of the future in the clinical study of craniocerebral traumatism. They believe that up to the present this method has not been sufficiently made use of by surgeons. Observations on seven cases are given in detail.

S. H. McKee.

Neurology

Acute Optic Neuritis with Sudden, Transient Blindness as a Primary Symptom of Acute Anterior Poliomyelitis: Report of a Case. V. Much and A. Hüppi, Klin. Monatsbl. f. Augenh. 93: 333 (Sept.) 1934.

A case of acute anterior poliomyelitis in a woman, aged 37, is reported in detail, and the report is illustrated with eight charts of the fields of vision. The peculiar symptoms are discussed. The first symptoms were headache and a "cold" followed by reduction of vision to mere perception of light on the third day. The ocular symptoms were severe acute optic neuritis, disturbances of the pupils (paralysis of the sphincter and anisocoria) and paresis of the muscles of accommodation. Sensory disorders did not exist during the course of the disease, and the meninges were only slightly involved. The authors exclude a connection between the inflammation of the optic nerve and that of the spinal cord. In their opinion an infectious virus was present and gave rise to the optic neuritis. This initial symptom was followed by the inflammation of the spinal cord. The optic neuritis was a localized process, not caused via brain centers or meninges. The disturbances of accommodation and the internal ophthalmoparalysis were caused by a lesion of the nuclear area by the virus in analogy with the process in the optic nerve. The authors are inclined to interpret the lack of correlation between the reaction to light and accommodation as Argyll Robertson's phenomenon. Inhalation of amyl nitrite seems to have been at least contributary in completely restoring the function of the optic nerve, as it had been in previous cases observed by the authors.

K. L. Stoll.

Ocular Muscles

Congenital Paralysis of Lateral Movements of the Eyes with Unilateral Facial Paralysis. L. Dupuy-Dutemps, Bull. Soc. d'opht. de Paris, July 1934, p. 365.

At the age of 8 years, the oldest of three children showed the rare condition of paralysis of lateral gaze. The two younger children had no anomalies. With this condition and complete paralysis of the right facial nerve the child presented a strange physiognomy.

In spite of the child's intelligence and the normal fundi the visual acuity could not be enhanced from 0.3 for the right eye and 0.6 for the left. The eyes were directed parallel, without apparent strabismus. The left facial nerve was intact. The movements upward and downward were excellent, and the convergence was normal.

The initial observation of this type of case was made by Foville in 1858. The work of Laborde, Duval and Bernheimer demonstrated that the nucleus of the sixth cranial nerve is the common motor center for laterality of gaze. The proximity of the facial and abducens nerves may account for the involvement of both nerves. Cases reported by Harlan (1875), Möbius (1888), Scharpinger (1889), Jacquean (1903), Fryer (1903) and Bielschowsky in the Graefe-Saemisch handbook showed a bilateral facial paralysis. In spite of the lack of anatomic investigation it is reasonable to suppose that the lesion is one of congenital damage to the cells of the sixth nucleus. L. L. MAYER.

CONVERGENCE INSUFFICIENCY OF THE OCULAR BULB IN PERIPHERAL FACIAL PARALYSIS (ROASENDA'S PHENOMONON) AND ITS GENETIC MECHANISM. R. GALLENGA, Rassegna ital. d'ottal. 3: 451 (May-June) 1934.

The invariable association of convergence insufficiency with a peripheral palsy tends to disprove the thesis that there is a central origin for the lesion. It is really unilateral and affects the eye on the same side as the paralysis. Roasenda described this phenomenon in 1932.

Today, in Gallenga's view, the condition cannot be regarded strictly as a convergence insufficiency. His continuous and repeated original researches into the nature of the lacrimal muscle of Horner have led him to the conclusion that this muscle, besides presiding over the mechanism for the elimination of tears, is a rudimentary synergist to the internal rectus. It partakes of a double innervation from the third and seventh cranial nerves. Therefore, a paralysis of the seventh nerve weakens adduction until recovery takes place. The entire "muscular system" of the internal rectus becomes insufficient to achieve maximal convergence.

In persons in whom the muscle has a predominating facial nerve innervation, Roasenda's phenomenon will be less evident or absent, whereas in those in whom it has a fetal (double) type of innervation, a paralysis of the seventh nerve will handicap maximal contraction of the internal rectus. V. R. SYRACUSE.

Operations

MODIFICATION OF THE OPERATION OF DENIG. N. TRANTAS, Bull. Soc. d'opht. de Paris, July 1934, p. 368.

A Canadian, 30 years old, had trachoma of long standing. Both eyes were affected, vision being reduced to the point of counting of fingers at 1 meter with the right eye and at 0.3 cm. with the left eye. The lids responded well to ordinary treatment, but in the corneas the keratitic process persisted. The right eye was operated on, the modification of the Denig operation proposed by A. Trantas of Athens being used. After peritomy a circle of conjunctiva from 4 to 5 mm. wide was

excised and replaced by buccal mucous membrane, which was sewed to the conjunctiva still surrounding the limbus and to that in the periphery. A similar operation was performed on the left eye. The acute symptoms subsided rapidly, and after seven months the visual acuity of the right eye increased to 4/10 with use of a stenopeic slit and that of the left eye to 1/4. In order to overcome the defects of the Denig procedure, Trantas uses as a graft a complete circle and sutures it, which prevents necrosis. Six other cases are reported in detail to show the efficacy of the procedure. A bibliography and drawings are furnished.

L. L. MAYER.

A SIMPLIFIED METHOD OF OBTAINING PALPEBRAL AKINESIA. A. DE LIETO VOLLARO, Rassegna ital. d'ottal. **1**: 177 (March-April) 1932.

De Lieto Vollaro, reviews the technical procedures advocated by van Lint, Villard and Rochat to obtain a temporary paralysis of the orbicularis oculi in operative interventions on the eyeball and particularly in extraction of cataract. Then he describes his own simplified method of obtaining palpebral akinesia. Four per cent cocaine hydrochloride with addition of 1 drop of epinephrine hydrochloride (1 : 1,000) for every cubic centimeter is injected twice, in amounts of 0.25 cc., into the orbicularis at the inner and at the outer canthus, and the injection is followed by massage and compression of the injected fluid against the adjacent bony planes. In a few minutes, there is a relaxation of the orbicularis, as evidenced by a slight lagophthalmos which reaches its maximum after ten minutes. The resulting paralysis makes voluntary and even forceful attempts at closure of the lids ineffective or incomplete. Thus operative accidents, particularly prolapse and loss of vitreous during extraction of cataract, due to sudden and uncontrolled contraction of the lids is prevented.

V. R. SYRACUSE.

A METHOD OF OBTAINING BOTH BULBAR AND PALPEBRAL AKINESIA. A. DE LIETO VOLLARO, Rassegna ital. d'ottal. **3**: 3 (Jan.-Feb.) 1934.

De Lieto Vollaro described his method of obtaining palpebral akinesia in 1932. To this he now adds akinesia of the external ocular muscles. He injects 4 per cent cocaine hydrochloride with epinephrine through the bulbar conjunctiva around the tendinous portions of the external recti. Thus by these two methods the orbicularis and the recti (and even the oblique muscles) are affected. The injections are made without a speculum; the patient merely turns his eye in the appropriate direction. The operator tries to avoid the larger conjunctival vessels. Gentle massage is then carried out over the closed lids to influence the deeper oblique muscles.

This method of anesthetizing the ocular muscles does not altogether abolish the voluntary movements which it is desired to abolish, but it is very effective in preventing otherwise uncontrollable brusque movements or pressure.

De Lieto Vollaro has noted a very considerable diminution in losses of vitreous in complicated extractions of cataracts and in all other operations in which loss of fluid vitreous appeared inevitable or was expected.

V. R. SYRACUSE.

Orbit, Eyeball and Accessory Sinuses

A Case of Chalkosis Oculi. C. K. Lin, Chinese M. J. 48: 965, 1934.

Three metallic splinters, composed chiefly of copper, were present in the vitreous of an eye following the explosion of a shell. Attempt at removal was considered unjustifiable. They were tolerated without severe inflammation. The exact time of onset of signs of chalkosis is not known, but three and one-half years later there were definite signs of this condition in the cornea, lens and vitreous. A visual acuity of 6/15 was then maintained for five months. At the end of this period the sunflower cataract was less pronounced and the vitreous clearer, signs which Lin believes indicated that the chalkosis was undergoing retrogressive changes. Several withdrawals of the aqueous were made in an effort to combat the chalkosis.

O. P. Perkins.

Fatty Degeneration of the Eyeball. F. Caramazza, Rassegna ital. d'ottal. 3: 499 (July-Aug.) 1934.

The researches of de Lieto Vollaro established and others confirmed the fact that arcus senilis, due to an infiltration of granules and droplets of fat into the stroma of the peripheral cornea, is but the visible manifestation of its more widespread presence in the senile eye. "Cholesterol steatosis" is a term now commonly applied to it. In the senile eye it is a physiologic process.

However, fatty degeneration is also met in ocular tissues previously subjected to injury, more particularly, in eyes in which preceding lesions have compromised vision.

The most characteristic picture of a pathologic adiposity of the globe is certainly that of xanthomatosis bulbi, a rather rare disease. Local and general causes contribute to this accumulation, such as stasis (steatosis of the iris and ciliary body, glaucoma) and the systemic factors of senility, hypercholesteremia and special individual disposition. If these factors were not necessary for the development of the characteristic alterations, xanthomatosis bulbi would be more frequent.

V. R. Syracuse.

Physiology

The Nutrition and Circulation of Avascular Parts of the Eye. Kawaguchi, Acta soc. ophth. jap. 38: 87 (June) 1934.

Kawaguchi studied the sugar contents of the aqueous and vitreous fluids in rabbits' eyes under normal conditions with the aid of the Hagedorn-Jensen micromethod. In relation to circulation and nutrition, the avascular parts of the eye may be regarded as divided into two parts by the surface of the iris. In the anterior part, the metabolism is more active in the aqueous than in the cornea; in the posterior part it is more active in the vitreous than in the lens. The aqueous is furnished not only by the ciliary body but by the surface of the iris. The source of the vitreous fluid is principally the ciliary body, which produces the posterior aqueous humor, though the retina and the choroid in the equatorial region, less in their peripheric parts, are also active. The sugar content of the vitreous under normal conditions varies with location.

The greatest amount is found in the anterior half of the vitreous, particularly in its peripheric parts, then in the equatorial region, and last, in the central part. After injecting a solution of dextrose intravenously and examining the vitreous after certain intervals of time, Kawaguchi found that the dextrose was secreted by the ciliary body and the equatorial retina and choroid; it then gradually made its appearance in the center and thereafter in the peripheric and posterior parts of the vitreous. It was several hours before conditions were again normal. The entire cornea with the exception of small parts at the limbus receives its nutrition entirely from the aqueous. Its metabolism takes place proportionally with that of the aqueous. The sugar content in the lens under normal conditions is also different in different parts. It decreases beginning at the equatorial region, then from the anterior and posterior poles, and finally the center of the lens. The metabolism of the lens takes place normally over its entire surface, especially in the region of the equator. Under pathologic conditions the lens receives its nutrition from the aqueous humor and probably from the so-called retrolental space, acting on the posterior pole.

A. KNAPP.

Refraction and Accommodation

FORM OF POINT FOCAL CORRECTING LENSES. F. OSTWALT, Arch. d'opht. 51: 452 (July) 1934.

After thirty years Ostwalt has recalculated the theoretical curves for point focal lenses. He refers to the criticisms of his work made by von Rohr, which he thinks were quite proper. He points out the necessity of basing the mathematical calculations on the image at the center of rotation of the eye and on the consideration of the compound optical system of the eye itself. The results of all this mathematical work are presented in tables and graphs. The outcome is the design of a lens with much less strongly curved surfaces. Such lenses are easier and cheaper to manufacture.

S. B. MARLOW.

Retina and Optic Nerve

TRAUMATIC ANGIOPATHY OF THE RETINA. MARC AMSLER, Ann. d'ocul. 171: 568 (July) 1934.

This disease, described for the first time in 1910 by Purtscher at the Thirty-Sixth Congress at Heidelberg, is rare. Twenty-five cases, more or less typical, affecting thirty-two eyes, have been reported to date. With the present report of five cases, affecting six eyes, there will have been thirty cases in thirty-eight eyes. The observations are clinical only, none of the eyes having been examined pathologically.

The white spots in the retina are typical. Amsler compares them to snowflakes or wadding in packets. The spots are of a milky whiteness and of variable shape, often rounded, and they vary in size from one fourth to one half of the diameter of the papilla or a little more. They are numerous, and are isolated or confluent. They are situated generally, but not exclusively, along the veins, which they may cover partially or completely, proving that these white spots are on the surface of the retina, in the bed of its fibers, between these and the internal limiting membrane.

With regard to the etiology, two views are discussed: (1) that the disease is of cranial origin, which is the view of Purtscher and Vogt, and (2) that the condition is purely ocular, the view of Stahli, Best and Marchesani.

There are a bibliography and four colored illustrations.

S. H. McKee.

Treatment of Detachment of the Retina Without Visible Tears by Diathermocoagulation. P. Jeandelize, R. Baudot and A. Gault, Arch. d'opht. **51:** 511 (Aug.) 1934.

The authors describe the procedure which they have adopted in cases of detachment of the retina in which it is impossible to localize tears or to determine positively that tears are present, because of vitreous opacity, cataract or the nature of the detachment. Believing in the importance of closing or walling off tears, they are guided by the history given by the patient as to the first appearance of symptoms. On this basis they localize the original lesion in that part of the retina corresponding to the clinically described onset. They believe that diathermocoagulation is the method of choice. They report the results obtained in ten detachments treated by Šafář's method: two failures, one uncertain result and seven reattachments. The visual results were not as good as might be expected in cases in which tears are localized or excluded. As a result of their experience with these cases the authors are convinced that detachment without tears is susceptible to cure, although the prognosis is not so favorable.

S. B. Marlow.

Preretinal Hemorrhages with Inundation of the Vitreous and Interstitial Keratitis. Bonnet and Paufique, Bull. Soc. d'opht. de Paris, June 1934, p. 341.

A 41 year old woman with a past history including only articular rheumatism at the age of 38 and ocular inflammation of the conjunctiva at the age of 10 had had trouble with the right eye for the past six months. At the onset she saw a large black speck in front of this eye. She was given chloride of acetylcholine intramuscularly without relief. The visual acuity of the right eye equaled perception of light; that of the left eye, 1/8 with correction. General examination gave negative results except for a cardiac murmur. The slit lamp showed that in the right eye there was no conjunctival reaction, and that the anterior chamber, iris and lens were normal. The cornea had a diffuse superficial clouding with discrete vascularization. On the posterior surface some deposits were visible. The posterior capsule and the vitreous evidenced a few conglomerate masses of cells. In the left eye there were profound changes in the superficial vessels of the conjunctiva and cornea with a form of nodular interstitial keratitis. The right fundus showed proliferating retinitis. The left disk was hyperemic with an area of very black blood below. The posterior vitreous was inundated. The Wassermann reaction of the blood was negative. The case is reported in detail because of the unusualness.

L. L. Mayer.

OPTIC ATROPHIES AND PERICAROTID SYMPATHECTOMY. A. MAGITOT, Bull. Soc. d'opht. de Paris, July 1934, p. 358.

At the March meeting of the Society of Ophthalmology of Paris Magitot presented the technic of the operation. In practice the decortication of the carotid gland is done bilaterally with an interval of from fifteen to twenty days between the two operations. To show the results of the increase of vascular supply to the optic fibers not entirely degenerated Magitot presents six case histories.

1. A man of 30, with familial optic atrophy and visual acuity equal to counting fingers at 15 cm., was able to read chapter headings in a book and had visual acuity estimated as 1/25. His visual fields were also enlarged. Subsequent neurosurgical intervention revealed chronic arachnoiditis. Recovery has been very satisfactory.

2. A man of 35 was syphilitic and had been treated with malaria. The Wassermann reaction was fixed, and optic atrophy was advanced. Visual acuity on the right was zero; on the left, 1/20. Following operation perception of light was regained in the right eye, and the left eye had vision of 1/10. The visual fields increased so that he was able to get around by himself.

3. A man of 45 had an old syphilitic optic atrophy and had been treated with malaria. After the first operation the visual acuity in the right eye increased from 1/10 to 3/10 in six months. It increased to 4/10 a little later, so that the second operation may account for the greater increase.

4. A man of 56 years had lowered vision as a result of arteriosclerosis. The visual acuity of the right eye was reduced to 1/25. After a double operation vision of 4/10 was recorded.

5. A woman had pigmentary chorioretinitis and optic atrophy, progressive in spite of all therapy. Visual acuity on the left was zero; on the right, 1/50. After a double operation the disk regained some color, the arteries increased in size, and the blood pressure was greatly augmented. With the left eye the patient was now able to count fingers, and vision in the right eye increased to 2/10.

6. A rubber worker of 52 had retrobulbar neuritis due to an intoxication with carbon disulphide. Lowered vision had existed for eight months. Treatment with chloride of acetylcholine and strychnine were of no avail. Visual acuity was 1/10 in either eye. After the first operation vision increased to 7/10 and 9/10. Finally six days after the second operation vision was 10/10 in either eye, with entire loss of the scotomas.

Magitot emphasizes the fact that the operative procedure allows blood to enter the smaller vessels, which lose their function very early in a diseased condition.

L. L. MAYER.

THE EFFECTIVE PUPILLOMOTOR AREA OF THE RETINA. H. GASTEIGER, Arch. f. Augenh. **108:** 553, 1934.

Although Hess believes that the pupillomotor area of the retina is limited to a region approximately 4 mm. in diameter, other writers hold that a much larger area, if not the whole of the retina, is capable of giving a response of the pupil to light. In order to determine which

view is correct, Gasteiger examined, with the Hess pupilloscope, seventeen patients whose central vision was reduced from one cause or another. These patients were divided into two groups: those with central scotomas but normal fundi (retrobulbar neuritis) and those with ophthalmoscopically visible lesions. In the majority the pupillary reactions were normal; i. e., they had a motor discriminative acuity of 0.9 in spite of low central visual acuity. From this he concludes that not only the central portions of the retina but also the more peripheral parts are capable of giving a pupillomotor response. F. H. ADLER.

ORIGIN AND SIGNIFICANCE OF THE SUBRETINAL FLUID IN NEPHRITIC RETINITIS. Y. KOYANAGI, Arch. f. Ophth. **132**: 353 (Aug.) 1934.

Retinal detachment is found frequently in nephritic retinitis if the patients are examined during the last few weeks before death. It is caused by an effusion which contains a large amount of hyalin. The effusion takes its origin not from the choroidal or retinal vessels, but mainly from the pigment epithelium. The author bases this view on his pathologic observations in eleven eyes in which hyaline droplets were present in the subretinal effusion. He found the same type of droplets within cells of the pigment epithelium and therefore named them "droplet cells" (*Klin. Monatsbl. f. Augenh.* **80**: 437, 1928). By analogy to similar processes in the kidney, Koyanagi interprets the formation of the droplets as a sign of an active secretory process the aim of which is the elimination of certain toxic substances from the blood. The presence of mitochondria in the pigment epithelium of normal human eyes is also used as an argument in favor of the secretory activity of those cells. Good photomicrographic pictures accompany the paper.

P. C. KRONFELD.

THE ORIGIN OF TEARS IN THE RETINA AND OF IDIOPATHIC DETACHMENT OF THE RETINA. H. ARRUGA, Klin. Monatsbl. f. Augenh. **93**: 43 (July) 1934.

Tears were found by Leber in eleven of fifteen cases of detachment of the retina in 1882. Neither Leber nor Gonin nor other authors have given a satisfactory explanation of the tears in idiopathic detachment of the retina. Lindner's experiment showed how the tear enlarges, but not how it originates. The same statement may be made regarding Arruga's former report, in which he demonstrated the growth of the tears and the increase of the detachment by a series of pictures. In the present article, Arruga advances his views on the etiology of the tears, based on clinical observation, on microscopic examination of eyes with fresh detachments and on some experimental facts. Only idiopathic detachments are considered. Detachments resulting from tumors, parasites, choroidal exudates and postoperative traction by the vitreous are disregarded.

Only the diseased retina becomes detached. The normal retina, if severed for operative purposes, such as sclerotomy or extraction of foreign bodies from the vitreous, will reattach. Even a slightly diseased retina may remain attached while tears occur; e. g., in myopia. Pigmentation in the detached retinal tissue and in the tears is proof for the

existence of previous inflammatory processes in the retina and also in the choroid.

Microscopic examination in certain cases of recent detachment of the retina occasionally reveals remnants of vitreous tissue adherent to the detached portion, especially in the area of the tears. This important observation supports the theory of traction by the vitreous as a cause of detachment. Chemical or thermic irritation of the retina and choroid through the sclera will produce adhesions of these three membranes, including tissues of the vitreous. The latter will remain attached in the irritated area even after the globe has been subjected to hardening with alcohol. Retraction of the sclerosed retina plays a rôle in the formation of tears. Vascular degeneration of the retina may lead to production of a tear spontaneously by force of retraction or through a lesion of the globe or through violent concussion of the skull. Limited postinflammatory adhesion of the vitreous and retina may produce a detachment which permits a tear in some instances on motion of the globe. Existing tears are enlarged by vitreous entering the subretinal space; the retina may become reattached, unless it is too sclerotic. Motion of the eye, however, may cause dehiscence of a piece of degenerated retina which was attached to the vitreous. This piece may stick to the tissue of the vitreous or it may float in the vitreous.

K. L. STOLL.

THE DANGERS OF NEEDLE DIATHERMY. A. VOGT, Ztschr. f. Augenh. 83: 321 (July) 1934.

CATHODE ELECTROLYSIS AS A NEW METHOD FOR LOCALIZING AND CLOSING RETINAL TEARS. A. VOGT, Ztschr. f. Augenh. 83: 322 (July) 1934.

Studies carried out by Vogt with the diathermic needle on egg albumin and the eyes of animals showed that coagulation is dependent on the surface area of that part of the bare needle introduced into the tissue, also that it is greatest at the point where the needle enters the tissue. In the eye the needle has considerable coagulative effect on the choroid and attached retina, but the action decreases the deeper the needle penetrates the vitreous. He believes, therefore, that when the retina is detached, there is danger that the diathermic needle will produce a new hole in the retina without any coagulating action.

He has tried out the method of electrolysis with the galvanic current in retinal detachment, using a simple apparatus similar to that commonly employed in the destruction of cilia. The positive pole is placed at any convenient location on the eyeball; electrolysis occurs at the needle, which is the negative pole. Two milliamperes of current are used for from one-half to one second. He finds advantages in this method as follows: The electrolytic needle has a deep as well as a superficial action. It is superior to the diathermic needle in that better orientation is secured at the time of operation. Its destructive action is not so great as that of the diathermic needle, the actual cautery or the caustics. It is far less expensive than the diathermic needle.

In a footnote to the second article, Vogt states that he had good results in seven cases of retinal detachment in which he used catholysis.

H. L. BEGLE.

STUDIES ON VASCULAR SCLEROSIS OF THE RETINA: CLINICAL OBSERVATIONS. IITUKA, Acta soc. ophth. jap. **38**: 74 (June) 1934.

Vascular sclerosis is not always associated with hypertension, and some authors have stated that frequently sclerosis in the eyeground may be noted before sclerosis has become general. Iituka has examined one hundred cases of vascular sclerosis of the retina and comes to the following conclusions: The changes observed are not only morphologic but optical. The latter changes consist in alterations of color and of the reflex-streak of the retinal vessels. The sclerosis is most marked in the vessels about the disk and in the macular vessels. At present, it is not possible to say in which position the retinal vessels first become affected. In fourteen cases vascular changes were noted in eyes in which they had not been determined on general medical examination. Some cases of vascular sclerosis of the retina exhibit diffuse infiltration in the macular regions. The visual field is contracted more for blue than for red or for white. The author was able to confirm an enlargement of the scotomas due to the vascular tree, which corresponded to the vascular sclerosis in the retina.

A. KNAPP.

ADHESIVE CHORIORETINITIS FOLLOWING CHEMICAL CAUTERIZATION. NAKASHIMA and SAKURAI, Acta soc. ophth. jap. **38**: 77 (June) 1934.

In order to study the effect of chemical cauterization of the choroid and retina after trephining, the authors made a number of investigations on the eyes of normal rabbits. These experiments showed that momentary cauterization with potassium hydroxide causes complete necrosis of the retina, and that the internal limiting membrane becomes detached from the swollen nerve fiber layer. Five days after the operation the pigmented epithelial cells begin to wander into the area of the cauterized retina. The necrotic retina is completely absorbed within fifty days and is transformed into a glial membrane. The surrounding retina becomes detached shortly after cauterization, but this lasts only three days. One hour after the operation the choroid begins to be hyperemic, edematous and strongly infiltrated with leukocytes. After three days there is a new formation of connective tissue, and after five days the retina and choroid have become adherent at the margin of the cauterized retina. The swelling of the walls of the vessels and the coagulation of the contents remain visible for a long time in the cauterized choroid. If the cauterized membranes are perforated, the retina grows to the choroid at the margin of the perforation and at that of the cauterization. After five days the perforation is obliterated by new-formed connective tissue. The injury to the retina by chemical action is much greater than that by thermopuncture, but the adhesion is much firmer and broader.

A. KNAPP.

THE ORIGIN OF THE SUBRETINAL EFFUSION IN NEPHRITIC RETINITIS. KOYANAGI, Acta soc. ophth. jap. **38**: 78 (June) 1934.

Twelve patients with nephritic retinitis were examined by Koyanagi. He is convinced that if more ophthalmoscopic examinations were made in cases of this disease, particularly before the patients die, detach-

ment of the retina would be more frequently observed. He thinks that its cause undoubtedly lies in a primary effusion back of the retina. This effusion has a greater albumin content than normal blood. It therefore differs from a transudate or an exudate, and it surely cannot be the fluid of edema. He believes it to be a pathologic secretion from the retinal pigmentary epithelium, which acquires secreting activity and endeavors to eliminate the toxic substances obtained from the circulating blood. The retinal pigmentary epithelium shows enormous mitochondria, which then form hyaline and albuminous substances, previously described by Koyanagi under the name of drop cells. These substances collect in the subretinal spaces into an amorphous coagulum which can lead to a detachment of the retina.

A. KNAPP.

Uvea

THE PATHOGENESIS OF DETACHMENT OF THE POSTERIOR PIGMENTED LAYER OF THE IRIS. M. CORRADO, Ann. di ottal. e clin. ocul. **62:** 573 (July) 1934.

Occasionally after injuries or after iridectomy the pigmented layer of the iris may be separated from the stroma and remain adherent to the lens or float freely in the anterior chamber. From a consideration of embryologic development and of variations observed in the adult iris the suspicion is aroused that in certain eyes the attachments between the two layers may be insufficient, such eyes being predisposed to detachment of the pigmented layer. Corrado studied histologically ten globes removed for glaucoma, penetrating wound and metastatic ophthalmia. In some of the eyes with widely dilated pupils, spaces had formed between the two layers, while in others no such spaces were present. Such spaces were present chiefly in the medial portions of the iris where the contraction of the posterior portion in mydriasis is especially effective. The posterior layer was thrown into folds in eyes with dilated pupils. When extensive posterior synechiae were present the two layers usually remained in contact. When inflammation had led to ectropion of the pigment border, spaces were sometimes present between the two layers. In eyes with peripheral anterior synechiae the layers were sometimes in contact, while in other eyes separation between the layers was present. From these observations it is concluded that inflammatory and mechanical factors do not modify essentially the relations between the two layers, but that congenital preexisting conditions form the factors deciding whether separation of the posterior layer will occur. These conditions may perhaps depend on an unequal growth of the two layers such that the posterior layer is thrown into folds which prevent intimate contact with the anterior layer.

S. R. GIFFORD.

CORNEAL COMPLICATIONS IN TUBERCULOUS IRIDOCYCLITIS: REPORT OF CASES. A. SIEGRIST, Klin. Monatsbl. f. Augenh. **93:** 289 (Sept.) 1934.

In a well illustrated article Siegrist describes his clinical observations on corneal complications in tuberculous iridocyclitis.

1. Precipitates varying in size from dustlike dots to what he calls "giant precipitates" may cause localized inflammation of the cornea.

Toxins from these precipitates, especially from those containing tubercle bacilli or their débris, involve the deeper layers of the cornea. Round cells and new blood vessels can be seen invading the anterior layers of the cornea.

2. Tuberculous proliferations arising from the tuberculous iris have been observed to protrude into the anterior chamber, some of them resting on the inside of the cornea. Toxin may penetrate into the intact Descemet's membrane, causing an inflammation of the adjoining corneal parenchyma.

3. Tuberculous tissue from the iris may advance to the inner layer of the cornea, where it may destroy the endothelium and Descemet's membrane or even proliferate into it.

4. Tuberculous proliferations of the ciliary body and of the root of the iris penetrated the pectinate ligament and entered the canal of Schlemm. Some infested the sclera and formed nodules or elevations which appeared of a bluish hue below the conjunctiva. Thence they progressed in linear arrangements from the corneosclera into every layer of the cornea.

5. The tuberculous formation in the ciliary body occasionally perforated the sclera broadly, involving also the adjoining cornea. Round cells were observed to destroy the cornea far into its center, causing complete change of its original structure and leading to the formation of staphylomas.

6. Siegrist concedes that toxins may penetrate from the aqueous humor into the inner layers of the cornea; he found, however, no proof for it in his material. Specific or nonspecific disturbances of nutrition of the cornea may lead to opacification and degeneration as a result of tuberculosis of the uvea and sclera. Parenchymatous opacities, especially those of the deeper layers of the cornea, appearing in severe cases of iridocyclitis, may be explained by processes of this kind.

K. L. STOLL.

A CASE OF INACTIVE DISSEMINATED CHOROIDITIS WITH COMPLETE AUTOPSY. W. ROHRSCHNEIDER and G. SPONHOLZ, Klin. Monatsbl. f. Augenh. **93**: 314 (Sept.) 1934.

After reviewing the literature on uveal tuberculosis and on general changes found in postmortem examination Rohrschneider and Sponholz report the case of a man, aged 53, who died from carcinoma of the stomach with a metastasis to the brain. Ophthalmoscopic examination of the right eye showed moderate choking of the disk with linear retinal hemorrhages around the disk and an inactive disseminated choroiditis with foci of atrophy and pigmentation. The margin of the disk in the left eye was not well outlined, and the choroidal foci in this eye were less numerous than those in the right eye. The Wassermann reactions of the blood and cerebrospinal fluid were negative. A complete postmortem examination confirmed the clinical diagnosis of carcinoma of the stomach and disclosed a metastasis in the left occipital pole of the brain. A primary tuberculous complex in the intestines and two diseased paraaortal glands were present. Histologically, these glands suggested that they became diseased later than the choroid. The fact, however, that some glands showed active tuberculosis justified the opinion that the

primary complex never came to a rest and that it may have led to a hematogenous metastasis in the eyes. The tuberculous nature of the choroiditis was not firmly established but was accepted theoretically. The case furnishes proof that the channel through which the primary complex voids into the blood current need not be traceable. Foci of hematogenous infection were found only in the eyes. Neither the clinical findings nor the postmortem observations furnished evidence for a syphilitic disease of the choroid.

K. L. STOLL.

Sympathetic Ophthalmia

ANATOMIC AND BACTERIOLOGIC EXAMINATION OF AN EYE REMOVED BECAUSE OF SYMPATHETIC OPHTHALMIA IN A CASE IN WHICH THE SYMPATHIZING EYE WAS CURED WITH INJECTIONS OF AO. NAGAYAMA, Acta soc. ophth. jap. **38:** 69 (June) 1934.

A similarity in the pathologic factors of sympathetic ophthalmia and tuberculous uveitis has been frequently mentioned. In sympathetic ophthalmia sometimes typical nodules appear in the iris which seem to be favorably influenced by specific treatment with tuberculin. It cannot be said, however, that the favorable results of this treatment necessarily mean that sympathetic ophthalmia is tuberculous. The tuberculotoxic theory is not accepted by most authors. Meller, however, in 1932, obtained bacilli in cultures of the tissues of the injured eye and of the blood. Nagayama has recently observed a case in which the diagnosis was tuberculous sympathetic ophthalmia, but the tuberculous nature was not confirmed on pathologic, bacteriologic or experimental observation: A man 42 years of age had sympathetic iridocyclitis in one eye which had developed after an injury of the ciliary body. Three months later choroiditis developed in the other eye, which was cured by a course of treatment with a vaccine prepared from the protoplasm of many strains of tubercle bacilli. An attempt to demonstrate tubercle bacilli through culture by the method of Löwenstein failed. Transplantation of pieces of uveal tissue into the anterior chamber of rabbits' eyes gave negative results. Typical nodular formations were absent from the entire uvea, and caseation was not present. The infiltrating cells were epithelial cells, giant cells, plasma cells, lymphocytes, fibroblasts and eosinophils. There was a vascular formation in the newformed tissue in the anterior part of the vitreous, and the capillary layer in the choroid was intact. Nagayama therefore concludes that the favorable action of the injections of AO was nonspecific. Though he does not say definitely that tuberculous sympathetic ophthalmia may not exist, he concludes that in this particular case the process was not tuberculous, notwithstanding that it was favorably influenced by tuberculin.

A. KNAPP.

Therapeutics

CORECLISIS OR MEDICAMENTOUS SYNECHIECTOTOMY. ENRIQUE HUBER, Arch. de oftal. de Buenos Aires **8:** 210 (May) 1933.

After stressing the importance of rupturing synechiae in the treatment of inflammatory processes of the iris and referring to the employ-

ment by Fuchs of subconjunctival injections of epinephrine hydrochloride subsequent to dilation of the pupil with atropine, for this purpose, Huber reports several cases in which excellent results were obtained by Hamburger's levigyrous glaucosan employed in instillations and subconjunctival injections.

C. E. FINLAY.

AUTOHEMOTHERAPY IN TUBERCULAR PROCESSES OF THE ANTERIOR SEGMENT OF THE EYEBALL. A. GARCÍA MIRANDA, Arch. de oftal. hispano-am. **34**: 349 (July) 1934.

García Miranda reviews the present status of knowledge in connection with ocular tuberculosis, which he states is mostly secondary and belongs to Ranke's second stage. He calls attention to the different development of the disease in vascular and avascular tissues and to Schieck's autohemotherapy by which it is proposed to carry to tissues of the latter type defensive elements which they do not normally possess owing to their anatomic structure. He then refers to a series of experiments performed at Schieck's suggestion on two groups of rabbits with different tuberculous strains. In one group the injection was made intravenously, and in the other, into the anterior chamber. The bovine tuberculosis was more virulent; the intravenous injection produced, as a rule, disseminate tuberculous processes in the choroid. Repeated tests of the complement deviation for the presence of antibodies were negative as regards the anterior chamber and positive as regards the blood.

The author reports eighteen cases of tuberculosis of the anterior segment of the eyeball treated by autohemotherapy in Schieck's clinic with remarkably favorable results.

C. E. FINLAY.

Toxic Amblyopia

POSITIVE TRANSITORY CENTRAL SCOTOMA IN CHRONIC ALCOHOLISM. L. WEEKERS, Arch. d'opht. **51**: 497 (Aug.) 1934.

Weekers reviews the method of eliciting the scotoma which he first described in 1932. He then refers to the work of Morel (*Rev. d'oto-neuro-opht.* **11**: 81, 1933), who observed that similar positive scotomas occur in delirium tremens. Weekers quotes Morel's description of the way in which he elicited the scotomas in his cases. The phenomenon was indistinctly demonstrated in all cases and constitutes an important symptom of delirium tremens. The positive scotoma and visual hallucinations are intimately related, the author stating that the former is the cause of the latter. While positive scotomas may occur without hallucinations, the reverse never occurs. The visual hallucinations which occur are gray, uncolored shadows having an oval shape, the long axis horizontal. Their size varies with the distance at which they are seen. These characteristics are correlated with those of the positive scotomas which occur. These findings of Morel in delirium tremens and of Weekers in tobacco-alcohol retrobulbar neuritis appear to be identical phenomena. However, the latter outlines five points in which the two phenomena are dissimilar and which need further study. They are (1) the great difference in the method of elucidating the scotoma, (2) the spontaneous appearance of the scotoma in delirium tre-

mens, (3) the persistence of the scotoma in toxic neuritis for several weeks as compared with the ephemeral nature of that appearing in delirium tremens, (4) the loss of central visual acuity in retrobulbar neuritis as compared with its maintenance in delirium tremens although associated with considerable concentric contraction of the peripheral field and (5) the combination of alcohol and nicotine in relation to the scotoma. Weekers indicates that a great deal more work is necessary and suggests the application of this procedure to other forms of poisoning.

S. B. MARLOW.

Society Transactions

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Jan. 21, 1935

WEBB W. WEEKS, M.D., *Chairman*

MARK J. SCHOENBERG, M.D., *Presiding*

W. GUERNSEY FREY JR., M.D., *Secretary*

A CASE OF FILARIASIS SUBCONJUNCTIVALIS. DR. JOHN S. CREGAR.

This paper will be published in full in a later issue of the ARCHIVES.

REPORT OF A SERIES OF CASES EXAMINED BY THE OPHTHALMO-EIKONOMETER. DR. WENDELL L. HUGHES.

Aniseikonia is a condition of asymmetry in the ocular images relative to size or shape, and it is a frequent cause of the ocular discomfort continuing after correction of ordinary refractive errors and phorias. In a series of cases the symptoms found were: (1) persistent discomfort related to the eyes or head despite the application of the usual corrective procedures; (2) aching of the eyes or head; (3) general nervousness on attempted concentrated use of the eyes; (4) photophobia; (5) fatigue, and (6) burning, itching and various other asthenopic symptoms. The paper deals with the prerequisites for the test, the technic of examination with the ophthalmo-eikonometer and a description of the types of lenses prescribed and the principles involved in the correction of aniseikonia in 60 patients referred by oculists from New York and its vicinity. Total relief was obtained in 62 per cent and no material help in 38 per cent.

DISCUSSION

DR. LEWIS W. CRIGLER: In what percentage of the cases did Dr. Hughes find aniseikonia?

DR. MARK J. SCHOENBERG: How long have these patients been under observation, and has Dr. Hughes followed them up? What is the longest duration of the complaint? Also, has the psychic element any effect on the condition?

DR. GUERNSEY FREY: When the difficulty is due to fusing images of unequal size, will not the patients derive relief from merely covering one eye for a period, and may not this be a means of determining whether the eyes are suitable for aniseikonic correction?

DR. MORRIS DAVIDSON: I should like to ask what effect aniseikonia has on perception of depth, and what means have been employed to determine and measure that.

DR. HENRY MINSKY: I have referred 2 patients to Dr. Hughes. The first, who had had difficulty for many years, reported almost instant relief from symptoms. That must have been about six months ago, and he is still comfortable. The report on the second case included recommendation of a change in the cylinder and axis. In such a case, I think the patient should first get the correction that is advised in the ordinary sphere and cylinder. That is not costly, and the patient is more or less willing to do that since the other pair of glasses is rather expensive. This procedure will convince the patient and his ophthalmologist that it is not merely a change in the strength of the lens which does the trick. When that fails, the patient is more willing to get the correction for aniseikonia.

DR. WILLIS S. KNIGHTON: I should like to report a case of temporary aniseikonia inadvertently caused by an optician. My patient was wearing a +4.50 sphere before each eye, and when a new pair of glasses was obtained, he complained of vague discomfort. As you know, the magnification of the retinal image in aniseikonia is effected by the base curve in the slip-over lens; the power of the correcting lens is zero. An examination of the base curves of the patient's lenses showed one to be about —5, and the other, about —7. When these were made equal, the discomfort disappeared.

DR. RUDOLF AEBLI: It has been stated that an over-all aniseikonia or a meridional aniseikonia of 1 or 2 degrees produces various ocular and general symptoms. One knows that fusion is a psychical process, that it is elastic and plastic, and that images disparate to a considerable degree can be fused easily. In view of this, I should like to know what explanation is offered to account for the spectacular results said to follow size lens corrections of 1 or 2 degrees.

DR. WALTER HIPP: May I ask whether or not the fundamental theory of this is based on the nodal point?

DR. CONRAD BERENS: In a case in which diplopia persisted after five operations on the ocular muscles, a marked over-all and meridional difference in size was found. Correction of the aniseikonia resulted in comfortable binocular vision and freedom from diplopia in a large area of the field of binocular fixation.

A second patient had suffered great ocular discomfort for forty-five years. He had had tenotomies, occlusion, prismatic correction and orthoptic training, with only slight relief. Sensitiveness to light frequently compelled him to cover his right eye. Iseikonic lenses correcting an over-all meridional difference of 0.75 per cent have given comfortable binocular vision with little photophobia.

Another patient, operated on for exotropia and hypertropia, achieved binocular vision with iseikonic correction for an over-all difference of 4 per cent.

DR. EMANUEL M. JOSEPHSON: Dr. Lancaster, in a demonstration of eikonoscopy about two years ago, stated that it is impossible to secure any results when fusion is absent even if the failure of fusion is due to aniseikonia. I wish to ask Dr. Hughes whether he and his collaborators have made any progress in that direction. I have a number of patients who show momentary and fleeting fusion with obvious ani-

seikonia, in whom, according to Dr. Lancaster's statement, it will not be possible to secure aniseikonic correction or stimulation of fusion by that method.

DR. PERCY FRIDENBERG: Might it not be interesting as a check on aniseikonic correction to get a series of patients without symptoms and artificially produce a moderate degree of aniseikonia to see whether they acquire symptoms? It might be possible in that way to determine just what degree produces symptoms of eyestrain, and what normal subjects do with different images in the two eyes.

DR. HAROLD VAN LAMMERS: Perhaps I may answer several of the questions by stating my own experience: I am wearing an aniseikonic correction of an over-all difference of 0.75 per cent for relief from headache and discomfort which I had. I have worn it for over two months and there has been almost complete relief. Prior to that my glasses had been changed and changed, but on this last aniseikonic refraction my power lens was not changed. So, in answer to Dr. Minsky, I believe, if there is a psychic factor, aniseikonic correction is a good psychologic treatment.

DR. ARTHUR BIELSCHOWSKY: In a complicated case of absence of fusion, relief was obtained by correction of aniseikonia, and the difficulty reappeared when the patient removed his correction. Changing the size lens by 1 per cent caused the fusion to break. This probably represents false fusion, and it is only by the combination of lenses that he gets fusion.

DR. MARK J. SCHOENBERG: An important practical question is whether the Dartmouth unit can develop a practical and simple instrument or apparatus by means of which the examiner will be able to make a diagnosis of aniseikonia and prescribe the proper correction.

DR. WENDELL L. HUGHES: The 60 patients were referred for suspected aniseikonia, and I think the percentage, 95 per cent with aniseikonia, is unwarrantedly high; it does not represent the percentage in the ordinary practice. I may say that in the past year I have referred about 35 of my own patients for measurement of the aniseikonic factor because of continuing discomfort.

I have 2 patients who have been wearing their aniseikonic correction for years, one for three, and the other for four years. All of the patients in this first series of 60 have had their correction more than six months.

The duration of symptoms in these cases has varied from twenty-five years to two years. All of the patients had ordinary examinations for relief first, and quite rightly so, and when they found that they were not relieved from their symptoms by ordinary glasses, they were referred to the aniseikonic department for measurement of aniseikonia.

Monocular occlusion for diagnostic purposes introduces disturbing factors. I do not think one can rule out aniseikonia if discomfort is relieved by covering one eye.

The effect on perception of depth is important. A 5 per cent difference of size in the images precludes fusion. If you do not have fusion you do not have binocular perception of depth, and errors of varying amounts of size introduce various disturbances of the horoptor.

The tipped horoptor is frequently due to the presence of an enlarged image on one side. I have proved this in an experiment worked out at Dartmouth in which a magnifying size lens, when placed on alternate sides, produced tipping in alternate directions.

In regard to Dr. Minsky's case in which he experimented with the ordinary correction first and then added the size correction, that is what was done in most of the cases of this series. In most of them the sphere or cylinder was not changed to any extent; only the size factor.

In regard to Dr. Hipp's question, the examiner depends on the patient's judgment of the size of the image at 20 feet (6 meters) and then again at 16 inches (40.6 cm.), according to the technic outlined in these pictures. He gets the relative size at those two distances, which are ordinarily the two most used by the patient.

In regard to the questions of persons with aniseikonia not having symptoms, I think there are a great many people who have aniseikonia without symptoms, just as there are a great many people with astigmatism without symptoms. On the other hand, there are patients with aniseikonia who have symptoms, and when the condition is corrected, the symptoms disappear. I think that question was nicely answered by Dr. Knighton when he mentioned the case in which the optician put in a higher base curve on one side and introduced a false aniseikonia. The moment the lenses were made on equal base curves, the patient was symptom-free.

Demonstration of the Method Used at the Checking Station for Tonometers of the Knapp Memorial Hospital. Dr. Adolph Posner (by invitation).

This paper will be published in full in a later issue of the Archives.

The Ophthalmoscopic Differential Diagnosis Between Arteriosclerosis and Arteriolosclerosis. Dr. Jonas S. Friedenwald, Baltimore (by invitation).

Two types of sclerosis of the retinal arterial tree are described, namely, arteriosclerosis and arteriolosclerosis, which it is believed are pathologically distinct and occur predominantly in different age groups. These changes are associated with different clinical symptoms and modes of progress, and can be produced experimentally under entirely different conditions. The size of the blood vessels affected is not the determining factor, since vessels of the same order in the retina may show either type of change. Arteriosclerosis is characterized by the development of atheromatous plaques in the intima of the vessels, with subsequent fibrosis and calcification. This change is revealed ophthalmoscopically by: localized constrictions of the caliber of retinal arteries which are permanent and not spastic; generalized decrease in the caliber of the arteries; dulling of the arterial light streaks, and varying degrees of arteriovenous displacement and constriction. Arteriolosclerosis is described as a hyaline lipoid necrosis of the media. This is characterized in the early stages by dilatation and tortuosity of the larger retinal arteries and increased thickness of the walls of the vessels, with resulting increased width and brightness of the arterial light streak. Localized constrictions of caliber may be permanent or transitory; the latter are due to spasms.

DISCUSSION

DR. ARTHUR J. BEDELL, Albany, N. Y.: Dr. Friedenwald has for several years reported on the ophthalmoscopic differentiation between arteriosclerosis and arteriolosclerosis, and I am sure all the members appreciate his latest exposition of this intriguing subject.

At times it is difficult to decide whether a patient presents a dominance of arteriosclerosis or of arteriolosclerosis, for, usually, it seems that both are in evidence. To draw conclusions from the ophthalmoscopic view of the retinal vessels to the exclusion of the attendant signs of disease is often so confusing that the diagnosis cannot be made until the results of the general physical examination, including the laboratory findings, are reviewed. The essayist stresses the importance of the arterial reflex which is found in both conditions, but often so altered as to be of considerable significance. The reflection depends not only on the physical changes in the walls of the vessels but also on the brilliance of the ophthalmoscopic light, the type of instrument used, the general appearance of the fundus and the subconscious readjustment in the mind of the examiner as he notes the age and physical characteristics of the patient.

In health as well as in disease there is often a measurable difference in the caliber of the retinal vessels of the two eyes, and finally the width may depend on the duration of the disease. For instance, the examination of serial stereoscopic photographs of fundi showing sclerosed retinal vessels reveals that they are not always the same; in the earliest stages of arteriolosclerosis some may be of recognized normal caliber, not showing dilatation until a much later day. I am forced to great limits to be certain that borderline fundus changes are correctly classified, for I agree with the essayist that the prognosis is of prime importance, and, therefore, that it is extremely valuable when it can be made.

The essayist in his recent article in Cowdry's "Arteriosclerosis" gives little space to the importance of stereoscopic photographs of the fundus. This procedure is well worth while, for by serial photographs new light will be thrown on the mooted questions of the size, caliber and reflexes of vessels, and, eventually, there will be photographs for the correlation of the pathologic observations in the eye with those of the other organs affected.

DR. WALTER I. LILLIE, Philadelphia: I fully appreciate the lack of agreement among ophthalmologists as to the proper classification of the retinal vascular tree. Some agree with the essayist that both arteries and arterioles are present; others, myself included, believe that the vessels are all arterioles. The conservative upper limit for the diameter of arterioles has been placed at 125 microns; according to Wagener, that of the retinal vessels is rarely over 75 microns. The vascular lesions one perceives with the ophthalmoscope must, then, be arteriolar changes and are to be correlated with arteriolar disease, with no direct connection or relationship with atherosclerosis.

The types of retinal arterial changes are readily discernible with the ophthalmoscope, and when these changes are correlated properly, a definite clinical classification can be made.

Four types of arterial sclerosis have been described by Wagener, namely: (1) senile fibrosis and sclerosis, (2) consecutive or hypertensive sclerosis, (3) primary sclerosis and (4) secondary sclerosis.

This classification of retinal arteriolosclerosis is of great clinical value, and when observed and the changes properly interpreted, as they are by Dr. Wagener, much of the present confusion gives place to a better understanding of the clinical condition. Dr. Friedenwald has stressed the importance of being able to differentiate the types of sclerosis of the retinal vessels with the ophthalmoscope and to correlate these observations with the known histopathologic changes he has previously so ably described. There still is variance between the internist and the ophthalmologist as to the interpretation of these visible changes. The ophthalmologist has the advantage of an instrument of precision with which he can visualize active pathologic processes; and if he will develop his ability to interpret pathologic changes in the fundus correctly, the internist will seek his aid in the solution of clinical problems.

DR. SIGMUND A. AGATSTON: As has been pointed out by one of the speakers here, the retinal artery is an arteriole. Whatever happens to it is arteriolar, so one does not like to use the term "arteriosclerosis." The condition which Dr. Friedenwald described as arteriosclerosis, to the ophthalmologist is senile arteriolar sclerosis. It seems to me the whole subject is rather confusing to the man who has not concentrated on blood vessels, and it ought to be simplified. If you look at the fundus, not merely as an ophthalmologist, but also as a clinician, you may be better able to make distinctions. For instance, it is easy to classify arteriolar sclerosis as the senile type or as the hypertensive type. One knows that the senile type is caused by atheromatous plaques such as Dr. Fridenwald described, and that the other type is caused by spasm. The sclerosis in the hypertensive type is secondary to the spasm cutting off the blood supply with development of secondary fibrosis and hyalinization of the walls of the blood vessels. From the ophthalmologic standpoint, when one sees senile sclerosis one thinks of the early aging of the patient. I find that patients who show senile arteriolar sclerosis have sclerosis without spasm and without much hypertension, indicating premature or abnormal aging; on the other hand, the spastic type may occur in a patient of any age, even in a child, and it is secondary to spasm. One may encounter spasm in a patient without hypertension. The fact that the vessels are tortuous does not mean anything to me. A spasm is not organic at first. It is functional. It becomes an organic constriction only later, when the spasm is too persistent or recurs too frequently.

DR. EMANUEL M. JOSEPHSON: May I ask Dr. Friedenwald what may have been his experience with extract of adrenal cortex in controlling the manifestations of ocular arteriosclerosis and hypertension? My own experience with the use of this extract in the therapy of hypertension, as well as that in that of ocular manifestations of hypertension, has been that it sometimes gives rather remarkable relief.

DR. GORDON M. BRUCE: Several years ago, Guist of Vienna asserted that the corkscrew-like twists in the venules were pathognomonic of arteriolar sclerosis. In a series of more than a hundred cases I attempted to corroborate this. I am sure that I saw this phenomenon in patients

with arteriosclerosis of the senile type and even in patients who were apparently normal. I was therefore unable to confirm Guist's findings, and I should like to know whether Dr. Friedenwald's experience parallels my own.

DR. ROBERT K. LAMBERT: One is apt to think in a haphazard way of the retinal arterioles as being much the same as any other arterioles in the body. This is far from the fact, as Dr. Friedenwald has pointed out in other contributions. The retinal arterioles do not have to support the blood pressure by their walls alone; they are largely sustained by the intra-ocular pressure. Consequently, the wall of a retinal arteriole is much thinner than the wall of an arteriole of equal diameter elsewhere in the body. The participation of the intra-ocular pressure in the support of the retinal vessels might be utilized to throw some light on the problems of arteriosclerosis, for a persistent drop in intra-ocular pressure would influence the wall of the vessel in a way similar to elevation of the blood pressure. The wall would be subjected to much greater internal pressures and trauma. I should like to ask Dr. Friedenwald whether he has studied the retinal vessels after trephine operations or in hypotonia due to other causes.

DR. JONAS S. FRIEDENWALD: The differences of opinion between Drs. Lillie, Wagener and the Rochester group, and myself, arise in part from terminology and in part from different interpretations of fact. What I have called arteriosclerosis pathologists have called arteriosclerosis, namely, atheromatous plaques within the intima of the vessels, and such atheromatous plaques may occur in the retinal arteries. If one is not content to call this arteriosclerosis, and wishes to call it atheroma, I am satisfied, but it is not the same thing as the hyaline degeneration which one ordinarily sees in arteriolar sclerosis, so that in spite of the fact that most of the retinal arteries are of the arteriolar type, characteristic arteriosclerosis as I have defined it, and as it is generally accepted among pathologists, occurs within the retinal blood vessels, and with extraordinary frequency in the aged, especially at the point where the central retinal artery comes over the optic disk. A study by Bell a number of years ago showed that 80 per cent of people over 60 have atheromatous plaques at the point where the central retinal artery goes over the cribriform lamina.

I have tried to get from anatomists a statement as to what actually constitutes an arteriole and the distinguishing features between an artery and an arteriole. The professor of anatomy at the Johns Hopkins University tells me that the best definition which he can give is that an artery has an internal elastic lamina and a continuous sheet of musculature, and that the transformation of an artery to an arteriole may occur by the disappearance of the internal elastic lamina or by the disappearance of the continuity in the muscular coats. The retinal blood vessels are almost all arterioles; that is to say, the internal elastic lamina is seen only in the first and second major branches of the retinal arteries; beyond that it disappears. From about the same point onward, the muscular coat of the artery ceases to be a continuous sheet of muscle and becomes a series of separated muscle fibers. Dr. Towers of the department of anatomy at the Johns Hopkins University has studied the blood vessels from this standpoint with particular care, and found that the retinal blood vessels in dogs and cats do not show a continuous

sheet of musculature such as one finds in vessels of similar caliber elsewhere, but that there is a ring of muscle fibers, and then a little gap, and then another ring of fibers, and then another gap, and so on. This morphologic study is of great interest, because it helps one to understand why the spastic contractures of the retinal blood vessels are sometimes so sharply localized; it also shows that Dr. Lillie and the other gentlemen are correct in considering the retinal blood vessels, except the largest branches, as arterioles.

I wish to answer a few of the direct questions: I have no experience with extract of adrenal cortex. I do not agree with Guist that the tortuosities of the macular venules are a diagnostic sign of any significance in relation to arteriolar sclerosis. When it occurs it seems to me to be the result of arteriovenous compression. I have not made any special observations on the effect of lowering the intra-ocular pressure on the retinal artery.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Feb. 15, 1935

J. MILTON GRISCOM, M.D., *Chairman*

A. G. FEWELL, M.D., *Clerk*

DIVERGENCE PARALYSIS. DR. C. E. G. SHANNON.

A young man suffered from an attack of grip, followed eight days later by the rather sudden development of diplopia. The right eye appeared convergent about 10 degrees. At 15 feet (4.5 meters), homonymous diplopia was demonstrated. Esophoria and the diplopia diminished progressively as the light was approximated to the eyes, both disappearing at 12 inches (30.5 cm.). Within this limit there was crossed diplopia. With the gaze directed to the extreme right or left, diplopia disappeared entirely. Rotation of the eyeball was unrestricted in all directions. Within forty-eight hours, it was noted that single binocular vision was obtained with the test object 2 feet (61 cm.) from the eye instead of 1 foot (30 cm.). Improvement continued in this respect on subsequent examinations, and at the end of seven days the diplopia disappeared in all parts of the field.

The symptoms of divergence paralysis as summarized by Duane are as follows:

1. The lateral excursions of either eye in conjunction with the other eye are unimpaired.
2. The power of convergence is normal, not excessive.
3. The eyes tend to assume the position of convergence.
4. The deviation and diplopia tend to diminish as the eyes are rotated to the extreme right and left. (In the case presented, the diplopia disappeared entirely.) This test is definitely positive for far and near as well.
5. The power to overcome prisms, base in, should theoretically be abolished both for distance and near.

DISCUSSION

DR. MICHAEL BURNS: I first saw the patient on December 26 and found that he had a definite Romberg sign, diplopia, nystagmoid movements when looking to the right and left, and a slight difficulty of speech. In the upper extremities the muscles were far from flaccid, and there was good muscular tone. There was some tremor of the extended fingers. The deep reflexes were increased, which is the opposite of what we expect to find in poliomyelitis. The abdominal and cremasteric reflexes were present. In the lower extremities there was a suspicious bilateral Babinski reflex but no ankle clonus. The patellar and achilles reflexes were exaggerated. The vibratory sense was not impaired, nor was the sense of position. The muscular tone of the lower extremities was very good.

With double vision, nystagmoid movements and speech defect in view, I considered encephalitis, and admitted the patient to the Jefferson Medical College Hospital. On his arrival, an examination of the spinal fluid was made. Twenty-five cubic centimeters of fluid was removed. It showed 50 lymphocytes per cubic millimeter, no increase in globulin and a negative Wassermann reaction. The blood showed 6,400 leukocytes per cubic millimeter. After the withdrawal of the spinal fluid, the patient felt somewhat better. Three days later a second spinal tap was made. The fluid was not under pressure, and it contained 25 lymphocytes per cubic millimeter. The patient again felt better; there was beginning coordination of limbs, and although he could not walk he attempted to do so. A third spinal tap was made on January 3, at which time 25 cc. of fluid was removed. It was not under pressure; 12 lymphocytes were found. The fourth spinal puncture was made on January 5; the fluid was clear, colorless, not under pressure and contained 5 lymphocytes per cubic millimeter. By this time the patient walked; the Babinski sign had cleared up; the nystagmoid movements had entirely disappeared, and the diplopia was so much improved that he was able to do without the patch on his eye.

I looked on this case as one of aseptic encephalitis which cleared up after repeated spinal punctures, in which the lymphocytes decreased from 50 at the first puncture to 5 after the fourth tap.

DR. WILLIAM ZENTMAYER: Dr. Shannon's case differed from those I have seen in two respects: In all of my cases separation of the images at infinity was the same in the lateral fields of fixation as it was in the primary position of the eye; and, so far as I know, in all the patients the condition was permanent.

CONSERVATIVE TREATMENT OF MASSIVE CYSTOID ECTASES FOLLOWING EXTRACTION. DR. BURTON CHANCE.

I report the results of operation for the reduction of enormous cystoid ectases developing after extraction of cataracts in 3 patients applying to me for extraction of cataract in the fellow eye. The ectases had been produced by an accumulation of the aqueous, which was due to the fact that the anterior and posterior chambers in the affected eyes had been cut off from each other by the iris membrane. The ectases were treated by lacerating the lower portion of the iridocapsular mem-

brane with a Ziegler knife needle, thereby establishing communication between the chambers. All three eyes now have useful sight.

OCCLUSION OF THE CENTRAL RETINAL ARTERY. DR. HUNTER SCARLETT.

A man, 65 years old, lost vision in his right eye, with partial restoration after one hour, following a sudden jolt. Ophthalmoscopic examination the following day showed a dead-white central artery coming out of the physiologic cup.

The point where occlusion most frequently occurs is just back of the lamina cribrosa, and it is more apt to occur in sclerosed vessels when a thrombus is present. In this case, autopsy showed markedly sclerosed basal vessels, including the carotid arteries, and an occluded central retinal vessel, seen opthalmoscopically before death. Digital massage appeared to be of benefit in restoring partial sight.

DISCUSSION

DR. WILLIAM ZENTMAYER: There has recently been introduced a powerful vasodilator, acetylcholine, which is suggested for use in cases of obstruction in the central artery of the retina, and also in pigmentary degeneration of the retina. A few drops of a 10 per cent solution are injected into the vitreous. This produces a clouding of the vitreous which is said to clear in the course of a few days.

OPHTHALMIC SYMPTOMS IN BRAIN ABSCESS. DR. ALFRED COWAN.

The ocular findings in 44 cases of abscess of the brain are reported. In every case the diagnosis was verified either by operation or by post-mortem examination and an adequate ophthalmoscopic examination was made.

Of 17 patients with abscess of the frontal lobe, 5 had exophthalmos, swelling of the lids, chemosis of the conjunctiva and pain; 7 showed orbital involvement without exophthalmos; 1 had pain and tenderness of the globe, and 1 had lagophthalmos, part of a seventh nerve palsy. All these findings occurred on the side of the abscess. Choked disks were found in 14 of this group, always bilateral.

Nine patients with abscess of the temporal lobe showed no involvement of the lids, conjunctiva or extra-ocular muscles. Nystagmus on extreme lateral turning was observed in 1, and in 1 a nystagmus on looking laterally in the direction opposite to the lesion. Inequality and sluggish reaction of the pupils to light occurred in 2 instances, the smaller pupil on the side of the lesion in each. Choked disks were present in 5 patients. Homonymous field defects were present in 4 patients.

Of 7 patients with abscess of the parietal lobe, 3 had choked disks, and 1 was thought to have a paralysis of both external recti. In 1 patient the pupils reacted sluggishly to light, in 1 there was distinct hippus.

Of 7 patients with cerebellar abscess, paresis of conjugate upward rotation occurred in 1, and nystagmoid movements in 6. In 1 patient the head was turned toward the lesion, but the eyes were not turned. The pupils were always equal; they were fixed in 1 patient, sluggish in 1

and normal in 5. Choked disks were found in 3 of these patients. One member of this group had superior quadrantanopic defects in the fields opposite to the side of the lesion. One patient had small absolute central scotomas.

Four cases of abscess of the occipital lobe were recorded. In one there was bilateral ptosis; the patient had basilar meningitis. In all 4 cases the optic nerve heads were choked, 2 diopters minimum, and 11 diopters maximum. Two patients had homonymous hemianopia corresponding to the side of the lesion.

That choked disk in abscess of the brain is due to increase of intracranial pressure is well borne out in this series. For some time during or throughout the entire recorded course of their illness, 14 of the 28 patients with affected nerve heads had pure papilledemas. In 13 patients the degree of choking remained the same or even increased after operation. Of 44 patients with abscess of the brain, only 6 were free from abnormalities in the visual mechanism.

DISCUSSION

DR. WILLIAM ZENTMAYER: Eagleton claims that edema of the brain, an accompaniment of septic conditions of the brain, may be diagnosed at an early stage by the presence of irregular hemianopic fields, which are apt to show daily variations. He suggests daily taking of the fields in suspected cases, as by this method the diagnosis of abscess of the brain may sometimes be made before localizing symptoms are present.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

Annual Congress, April 4, 5 and 6, 1935

MR. R. FOSTER MOORE, F.R.C.S., *President*

RADIUM IN INTRA-OCULAR LESIONS. MR. R. FOSTER MOORE.

New growths in the eye can be watched under high magnification and their progress or recession noted from time to time. I have applied radium in 163 cases of gliomas, sarcomas and angiomas. Bilateral new growths occur in 1 of 5 cases and are the ones especially suitable for treatment with radium. It is important in cases of glioma to examine both eyes carefully under a general anesthetic in order to ascertain whether the apparently unaffected eye is really free from a growth. For glioma of the second eye, radium offers the only hope.

DISEASES OF THE BLOOD AND THEIR OPHTHALMOLOGIC COMPLICATIONS. SIR ARNOLD LAWSON.

It is probable that ocular hemorrhages seen in cases of primary anemia are not directly due to the blood changes themselves, but rather to nutritional defects in the capillary endothelium set up by toxins, the permeability of the endothelium being by this means increased. If toxins—the nature of which can at the present time be no more than

surmised—are the primary cause of retinal hemorrhages, it may explain why these hemorrhages occur only occasionally, why they are noted only in cases of severe anemia and only as a late manifestation of the disease, and why their prognostic significance is bad. In this way, therefore, there is a parallel with the changes seen in nephritis and in diabetes. Also, it explains, in contradistinction to many textbook statements, why hemorrhage of this kind is a rare accompaniment of pernicious anemia.

Eosinophilia is generally present in spring catarrh. Monocytosis (an increase in the number of large mononuclears) is a characteristic feature in sympathetic ophthalmitis, and the latter is treated very successfully on the same lines as syphilis and malaria. Eales' disease (juvenile vitreous hemorrhage) is associated with considerable difficulties. It is not yet known what influence a deficiency of blood calcium may have on the occurrence of hemorrhages.

DISCUSSION

MR. H. LETHABY TIDY: It is rare for ocular manifestations to occur as the direct result of blood changes. Practically all diseases of the blood, in their later and more severe stages, show a tendency to the production of hemorrhages, but the occurrence of retinal hemorrhages does not correspond closely to that of hemorrhages in other parts of the body in these conditions. In the days before the liver diet was employed, capillary hemorrhage was fairly common in pernicious anemia, though the latter is not really a hemorrhagic disease. In cases of arteriosclerosis, hemorrhages in the retina preceded bleedings elsewhere in the body. Retinal hemorrhages do not occur in hemophilia, even if the patient bleeds to death.

MR. E. C. DODDS: The two diseases which produce the most significant alterations in the chemical composition of the blood are diabetes mellitus and the various forms of nephritis. In diabetes the characteristic alterations in the blood are an increase in the dextrose and in the acetone bodies and a decrease in the alkaline reserves. The retinitis seems to be due to damage to the arterial walls in the retina, possibly caused by hyperglycemia. In this disease the normal blood sugar is not constant. The application of biochemistry to ophthalmologic problems has been, in my estimation, considerably neglected in the past. For example, the significance of the metabolism of the retina has never been considered in studying the pathology of the eye. It is hoped that the laboratory will be able to help along this line.

MR. P. N. PANTON: It requires years to acquire the capacity to make an accurate blood report and, in general, the diagnosis of blood conditions is sufficiently loose to obscure any correlation there may be between the retinal change and a particular state of the blood. Primary erythremia is a rare condition in which the commonest complication is, probably, venous thrombosis. In this condition, blindness from thrombosis of the central vein of the retina may occur. Leukemias are comparatively rare. In subjects with chloroma, the proptosis which commonly accompanies it may be the first reason for a visit to the ophthalmologist; it is, perhaps, the only blood disease in which the ophthalmic complications may be the most prominent feature of the syndrome.

PRESENT STATUS AS REGARDS LOCATING RUPTURES OF THE RETINA. DR. M. AMSLER, Lausanne, Switzerland.

For the purposes of argument it is admitted that all idiopathic detachments have holes. Gonin's advice was: "Act according to the tear." The technical problem of the localization of holes is being rapidly developed. Ophthalmoscopic examination to find and determine the meridian of the hole, and estimation of its distance from the ora in disk diameters to find the latitude are simple procedures which can be carried out without special instrument or apparatus. No localization apparatus, however ingenious, is absolutely infallible, because of the different shapes and sizes of eyes to be examined. Though the retinal hole is important, there are other important factors. Dealing with diffuse therapeutic agents, I should say that the accurately localizing single cautery puncture of Gonin has been replaced by the more diffuse action of other irritative and obliterative agents. The most recent modification is the cathodal micropuncture recommended by Vogt. These diffuse agents are shown to be efficacious in most cases after approximate or even inaccurate localization. For a small hole, a single obliterating scar should be enough.

TREATMENT OF DETACHMENT OF THE RETINA BY PYROMETRIC DIATHERMY. DR. LEON COPPEZ, Brussels, Belgium.

In the operative treatment of detachment of the retina, one tries to produce adhesion between the retina and the choroid close to the rupture. The most logical way to produce this result is by scleral diathermocoagulation. This provokes choroidal irritation without perforating the sclera; therefore the eye retains its tonus during the whole operation. The time of application must not exceed thirty seconds, and a temperature of 175 F. is attained in that time. It is contended that this is the only method by which one can insure regularity of the eschar.

CLINICAL RECORD AND HISTOLOGY OF TWO SUCCESSFUL CORNEAL GRAFTS IN MAN. MR. J. W. TUDOR THOMAS, Cardiff, Wales.

The opportunity of making a histologic examination of a successful corneal graft in man must be very rare, but 2 specimens of such grafts have been obtained from patients who died of diseases unconnected with the eye: in one case six months, in the other three weeks, after the grafting. For preparing the graft (the method has already been fully described) a trephine and scissors were used, the margins of the grafts being cut in a shelving manner. (Mr. Thomas also described the microscopic appearances of this series of preparations, projecting them on the screen. Two case histories were given to show the technic adopted and the conditions under which a corneal graft will unite.)

A THEORY OF THE EMBRYOLOGY OF OXYCEPHALY. MISS IDA MANN.

It has been suggested that oxycephaly is due to rickets, to syphilis, to fetal meningitis and to prenatal osteitis, but I think all these ideas can be abandoned. Of 91 patients with oxycephaly, only 3 showed evidence of rickets, and even in those the evidence was very indefinite. There seems to be an entire lack of evidence of any causal connection of

oxycephaly with syphilis. As to prenatal osteitis, the fact that no other bones are involved is strongly against that view. But the condition seems explicable with the idea that in oxycephaly there has been a failure of the visceral mesodermal regions, which are the last to be acquired and to develop to the full. I think oxycephaly is a clinical entity, and not the result of fortuitous disease of bones.

RECENT DEVELOPMENTS IN THE USE OF POLARIZED LIGHT IN OPHTHALMOLOGIC WORK, WITH SPECIAL REFERENCE TO ITS USE IN OPHTHALMOSCOPES. MR. J. D. MAGOR CARDELL.

By means of the polarized ray a clear view can be obtained of the fundus, even through a small slit. The surgeon's view, in using this method, is unrestricted in regard to the whole fundus. The same principle has been applied to retinoscopy. As a means of illumination, also, it has distinct possibilities.

A STUDY OF ACCOMMODATION BY PHOTOGRAPHY OF THE LIVING EYE AND CILIARY BODY IN A CASE OF ANIRIDIA. MR. EDGAR FINCHAM.

Opportunity was taken to obtain direct evidence of the change in the form of the lens and the anterior part of the ciliary body during accommodation in a case of traumatic aniridia. Two methods of illuminating the eye were used: transillumination of the media by light from the illuminated fundus and by the use of the slit lamp. The photographs show that in accommodation the equatorial diameter of the lens is reduced while its sagittal dimension is increased. The general change in the form of the lens is observed to apply to the nucleus of the lens as well as to the external surfaces. The photographs also show a centripetal movement of the inner edge of the ciliary body in accommodation.

FINAL REPORT ON A CASE OF RETINITIS PIGMENTOSA IN WHICH TREATMENT WAS BY CERVICAL SYMPATHECTOMY. MR. S. SPENCE MEIGHAN.

I reported to the 1931 congress a case of retinitis pigmentosa in which cervical sympathectomy had been performed four months previously. Shortly after the operation there was some improvement in the visual fields and the visual acuity in both eyes, but the time was too short to justify the drawing of conclusions from the case. In two other cases the condition has been treated in this manner. In the original case the improvement has not been maintained, the boy now being much worse than he was in 1931 before the operation. Of the other two patients, one has shown and maintained a slight improvement in visual acuity, but in both patients there has been a progressive contraction of the visual fields, indicating, apparently, that the disease process has not been arrested.

DISCUSSION

DR. W. WIBAUT, Amsterdam, The Netherlands: If sympathectomy improves the function in cases of retinitis pigmentosa for even a short time this is probably owing to the better circulation which is set up by it. In Amsterdam, success has been achieved by using estrogenic substance,

and the advantage of this is that it can be dropped and taken up again as the case seems to require.

MR. A. J. BALLANTYNE: Of three methods of dealing with this condition reported by the late Mr. Stephen Mayou (namely, administration of amyl nitrite, paracentesis of the cornea and trephining) the best results were obtained by the latter. In one such case of Mayou's the visual acuity improved and the fields were extended, and at the same time the night blindness ceased, for over a year. In 1 case Mayou repeated the trephining, with a further period of improvement following.

MR. MALCOLM HEPBURN: One should not be too discouraged because the operation failed in an advanced case of the condition. The aim should be to secure the subjects much earlier, before pigmentation is marked, because at that stage the neuro-epithelial layer or parts of it have been destroyed.

SIR ARNOLD LAWSON: I think it is obvious that sympathectomy cannot be of use when vascular disease is far advanced. But for thrombo-angiitis obliterans sympathectomy has produced brilliant results, though only in cases in which the obliteration of the arteries was spastic.

CAUSATION OF AMBLYOPIA FOLLOWING GASTRO-INTESTINAL HEMORRHAGE. MR. EUGENE WOLFF.

Amblyopia following hemorrhage is mostly associated with bleeding from the stomach or intestines, also with bleeding from the lungs and from the urethra. Recurrent hemorrhages are very important in association with the onset of blindness, for the latter occurs when the supply of oxygen to the tissues is less than it was when the hemorrhage took place. There are also, in these cases, other symptoms pointing to a general lack of oxygen. That the upper parts are more affected than the lower is probably because gravity determines a greater flow of blood to the lower regions. The immediate cause is probably a spasm of the arteries following this lack of oxygen.

MR. CHARLES GOULDEN: In the cases of blindness following severe bleeding which I have seen, there has been a series of hemorrhages. I did not see a case of blindness due to loss of blood among the soldiers in France, although the condition of many was reduced to severe anemia. I can think of many cases in which there were frequently repeated hemorrhages, but only 2 cases of blindness due to this type of hemorrhage have been recorded. So I do not think any one has arrived at the actual cause of the trouble.

MR. R. FOSTER MOORE: When there is blindness in one eye there may be some other factor which determines that. There may be a greater tendency to spasm on one side than on the other, and it is analogous to the fact that many people have migraine on one side and not on the other.

DR. HENRIQUEZ: In three years I have seen 5 instances of this condition; the patients were all blind in both eyes after gastro-intestinal hemorrhages; in only 1 case were there repeated hemorrhages.

MR. EUGENE WOLFF: Professor Gunn has recently shown that the dividing line between the life and death of the brain cells is a very nar-

row one; just massaging the heart and allowing a trickle of blood to get to the brain are sufficient to keep its cells alive, and the same applies to the retina. There may be some anatomic difference in the ophthalmic arteries in the two eyes. The patients who have this blindness are those whose hemoglobin content has already been reduced by hemorrhages.

A Few Hereditary Diseases of the Eye (The Bowman Lecture). Mr. C. H. Usher.

Choroideremia.—Mauthner, who discovered this condition in 1872, considered that it was an absence of choroid, and that the first disturbance was in the tissue around the primary optic vesicle, in consequence of which the retinal pigmented epithelium and rods and cones suffered. Leber considered it as a pigmentary atrophy of the retina and extreme atrophy of the choroid.

Atrophia Gyrata Choroideae et Retinae.—This term was introduced by Fuchs in 1896. In 11 of the cases noted the retinal arteries were normal or slightly contracted, and in 7 they were much contracted. The macula had the normal red color of the fundus in 4 cases, was atrophic in 2, and had a retinal pigment spot in 3. Of 29 eyes, the lens was clear in 12, and in 17 there were opacities. Of 18 cases, the vitreous was clear in 14, and in 4 there were opacities. The visual fields were full in 5 cases, concentrically contracted in 16, and presented a ring scotoma in 1; there was no note as to this in 5. Choroideremia and gyrate atrophy I regard as different stages of the same disease.

Angiomatosis Retinae (von Hippel's disease).—The literature contains reports of 119 cases of this condition, giving a description of the appearance of the fundus and the clinical history. This retinal disease advances slowly, affecting either eye or both eyes. In 36 of the cases both eyes were affected; in 29, the right eye alone; the left eye alone in 21. The third decade of life is the period in which this finding is most common.

Epicanthus.—Congenital ptosis with epicanthus is a characteristic condition which in some families is markedly hereditary. Consanguinity has not been recorded in association with any of the published pedigrees. In several of the pedigrees which I have collected an epicanthus seen at an early age disappeared after several years. In other cases, however, on examination many years afterward, the epicanthus was still present; for example, at the ages of 28 and 33.

Book Reviews

Le décollement de la rétine, pathogénie—traitement. By J. Gonin, professor of the ophthalmologic clinic, University of Lausanne. Price, 50 francs. Pp. 279, with 38 plates and 77 text pictures. Lausanne: Librairie Payot & Cie, 1934.

In his foreword Gonin pays a graceful tribute to his master, the late Prof. Marc Dufour, from whom he received the impetus, twenty-five years ago, first to master the anatomic and clinical aspects of retinal detachment and then to proceed to devise a method for its cure. The handsome volume here reviewed is a model of completed investigation. It is written with the greatest clarity of expression and can be comprehended by any one with a meager knowledge of the French language. The book is divided into two main parts. The first is concerned with the pathogenesis of retinal detachment and the second with the treatment. The arrangement of the subject matter of each part in chapters follows conventional lines. The mere reading of the titles of the various chapters is of absorbing interest.

Part I: Pathogenesis

In chapter I generalities are dealt with. The word "detachment" is a misnomer, as the retina is normally attached only at the disk and at the ora serrata, being applied to the choroid. One should speak of a displaced retina, but the word detachment is kept to conform to usage. The causes of detachment are: (1) traumatic, embracing contusions of the globe, perforating wounds and intra-ocular foreign bodies, and (2) nontraumatic, embracing intra-ocular tumors; circulatory disturbances (albuminuric retinitis, papilledema, orbital tumors, Coats' retinitis); inflammatory processes (metastatic retinitis, choroiditis, scleritis, retrobulbar abscess, etc.); hemorrhages in the vitreous or on the surface of the retina, with the development of membranes (retinitis proliferans); disseminated chorioretinitis or degenerative lesions confined to the anterior stretches of the fundus, with detachment and retraction of the vitreous. The latter changes and their rôle are still in dispute. Myopia is mentioned as not a true cause but a condition predisposing to detachment.

The determining causes of detachment are grouped as follows:

1. Elevation, as by vis a tergo; displacement of the choroid or thickening of it by a tumor, or outpouring of fluid between the choroid and retina.

2. Attraction (*attractio retinae*), as by a retracted vitreous or by contracting cicatricial bands.

3. Distention (*distensio retinae*), following contusion.

4. Depression of the globe (*depressio retinae*), which is the opposite of distention, as by a folding of the retina, consequent to diminution of the volume of the globe.

Chapter II is devoted to idiopathic retinal detachment, from the standpoint of pathologic anatomy. The great difficulty in studying the anatomic causes is that an eye is usually not enucleated in time to enable one to see conditions as they were at the beginning. Nevertheless Gonin discusses specimens which he believes demonstrate the initial processes. He classifies the detachments according to shape and throws light on the changes that take place in the retinal tissue, the vitreous, the intra-ocular fluids and the uveal tract. The following useful summary is given of the anatomic findings in fairly fresh material:

1. Retraction of the vitreous to the ciliary body.

2. The persistence of adhesions between the retracted mass and the surface of the retina in the anterior part of the globe.

3. The identity of preretinal and retroretinal fluids.

4. The presence of one or more retinal tears.

5. The frequent coincidence of tears with foci of anterior chorioretinitis.

Chapter III contains clinical observations on idiopathic detachment. In the summary are given the most important clinical facts observed by the author:

1. The onset is sudden in about two thirds of the cases.

2. There is absence of increase in tension, in spite of the ballooning forward of the retina.

3. The onset occurs most frequently in superior portions of the globe.

4. In the great majority of cases one or more tears are found in the region of the detachment.

5. The majority of the tears show a tag projecting into the vitreous.

6. Vitreous opacities and pigmented masses of fibrillar formations are almost constantly present on the surface of the retina.

7. There is a gradual sinking of a detachment from above to the lower parts.

In chapter IV are analyses of the various theories as to the pathogenesis of idiopathic detachment. The substance of Gonin's own ideas is as follows:

1. None of the anatomic causes can be disregarded. The importance of such causes varies with each case.

2. Distention of the globe in myopia or hydrophthalmos has less effect on the retina than on the vitreous and the uveal tract.

3. Attraction of the retina by adhesions on its anterior surface is the cause of many traumatic detachments. Preretinal membranes contribute to the folding of the retina, but they are the direct cause of neither the detachment nor the tears.

4. Ocular hypotony is probably derived from the same cause as retinal detachment, namely, vitreous retraction.

5. Choroidal exudation plays only a secondary rôle in idiopathic detachment. It accompanies certain noncharacteristic detachments of slow development, without a tear, which may heal spontaneously.

Chapter V is entitled "A Glance at the Etiology." In idiopathic detachment it is most difficult to weigh the etiologic factors. Myopia,

senility and all the influences affecting the nutrition of the uvea may be combined. Traumatism is only an exciting factor.

Part II: Treatment

Chapter I is set apart for a brief historical review of the various methods that have been devised in attempts to cure retinal detachment.

Chapter II deals with operative procedures, the aim being to produce permanent obliteration of the passage through which fluid seeps from the vitreous to the subretinal space. Gonin states that success depends more on preliminary measures than on operative technic. He dwells on the painstaking care and skill required to locate a tear accurately. The various methods used to obliterate the tear or tears are grouped together in this chapter. The precautions to be taken in operating are cited, and instructions as to the postoperative care are given.

Of 300 eyes with idiopathic detachments 78 were not operated on because of such reasons as lack of transparency of the media, too large a tear, inability to find a tear or the poor condition of the patient. In 118 eyes the condition was cured by 197 surgical interventions. The proportion of success varied with the age of the detachment. Sixty-six per cent of the operations were successful in cases of less than three weeks' duration; 51 per cent in cases of from three weeks' to three months' duration, and 37 per cent in cases of more than three months' duration.

Gonin believes that the operative results confirm his ideas as to the rôle played by the retinal tear. Any method will be ineffective unless it obliterates the opening. Particularly instructive are those cases in which obliteration of a tear superiorly results in curing a detachment in the inferior half of the fundus.

Chapter III describes adjuvant treatment, such as immobilization of the eyes by binocular bandage and atropinization.

Chapter IV is given over to measures aimed at the prevention of detachments.

Chapter V outlines the treatment for detachments other than those of idiopathic origin.

A most important and instructive feature of the book is the numerous illustrations in colors, many of which are reproductions of drawings. As works of art, with their descriptions, they greatly enrich the pages and enhance the value of the book. A full bibliography is appended.

Finally, in a short concluding chapter it is asserted that the present work makes no pretense to discuss in its entirety so vast and complex a subject as retinal detachment. Nevertheless those who peruse these pages will agree that no one has ever spoken so fully and authoritatively on detachment of the retina as Gonin has in this volume.

Bernard Samuels.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217 Faubourg St. Honoré, Paris.
Secretary-General pro tem: Dr. A. Churchill, 66 Boulevard St. Michel, Paris.

International Ophthalmologic Congress

Secretary: Dr. Francisco Poyales, Olozaga 3, Madrid.
Place: Cairo. Time: 1937.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. A. J. Ballantyne, 11, Sandyford Pl., Glasgow, C 3.
Secretary: Dr. J. Ringland Anderson, 108 Collins St., Melbourne.
Place: Melborurne. Time: Sept. 11-13, 1935.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. R. Foster Moore, 53, Harley St., London, W. I.
Secretary: Miss Ida Mann, 7, Wimpole St., London, W. I.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.

Royal Society of Medicine, Section of Ophthalmology

President. Dr. Ransom Pickard 31, East Southernhay, Exeter, England.
Secretary: Dr. J. D. Magor Cardell, 27, Weymouth St., London, W. 1.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

Chinese Ophthalmological Society of Peiping

President: Dr. P. H. Liu, Chi-Ming Eye Clinic, Ta Liu Pu Kau, Peiping.
Secretary: Dr. H. H. Feng, Peiping Union Medical College, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

Tsinan Ophthalmological Society

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. John Green, 3720 Washington Blvd., St. Louis.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Kansas City, Mo.: Time: 1936.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
President-Elect: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Cincinnati. Time: Sept. 16-20, 1935.

American Ophthalmological Society

President: Dr. Walter B. Lancaster, Boston.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Managing Director: Mr. Lewis H. Carris, 50 W. 50th St., New York.

SECTIONAL

New England Ophthalmological Society

President: Dr. James J. Regan, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. Benjamin Sachs, 483 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. H. G. Merrill, San Diego, Calif.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Francis A. Brugman, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Noble Dick, 1115 Terry Ave., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

Rock River Valley Eye, Ear, Nose and Throat society

President: Dr. Harry Shearer, 405 E. Grand Ave., Beloit, Wis.
Secretary-Treasurer: Dr. W. S. Beyer, 1101 Talcott Bldg., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Charles H. Baker, 805 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: First Friday of each month, except July and August.

Sioux Valley Eye and Ear Academy

President: Dr. J. J. Hompes, 1307 N St., Lincoln, Nebr.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.
Place: St. Louis. Time: November 1935.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. F. B. Fralich, 202 S. Main St., Ann Arbor, Mich.
Secretary-Treasurer: Dr. A. S. Barr, 201 S. Main St., Ann Arbor, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Claude W. McKee, 229 S. Main St., Greensburg.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.
Place: Indiana. Time: October 1935.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227, 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Arthur M. Yudkin, 257 Church St., New Haven.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. Herschel C. Crawford, 26 Lindon Ave., N. E., Atlanta.
Secretary-Treasurer: Dr. J. A. Smith, 700 Spring St., Macon.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Ora G. Brubaker, North Manchester.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. W. Dean, 532, 1st Ave., Council Bluffs.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.
Place: Council Bluffs. Time: Nov. 7, 1935.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. John W. Orr, 503 S. Saginaw St., Flint.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. James A. Reynolds, 78 S. 9th St., Minneapolis.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Lawrence G. Dunlap, 101 Main St., Anaconda.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
Secretary: Dr. William K. Campbell, 96 Third Ave., Long Branch.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Webb W. Weeks, 20 E. 53rd St., New York.
Secretary: Dr. John F. Fairbain, 925 Delaware Ave., Buffalo.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. W. R. Winn, 702 First Ave., S., Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 516 Fourth St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary and Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Josiah E. Smith, 60 Meeting St., Charleston.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Eugene Orr, 706 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. William Stookey, 54 E. South Temple St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welsh, 711 Boston Bldg., St. Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Beverley R. Kennon, 142 W. York St., Norfolk.
Secretary-Treasurer: Dr. George G. Hankins, Medical Arts Bldg., Newport News.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. W. F. Beckner, 1050 Fifth Ave., Huntington.
Secretary: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Alfred Stahl, 55 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Herschel Crawford, 478 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. Stacy C. Howell, 384 Peachtree St., N. E., Atlanta, Ga.
Place: Academy of Medicine, 13 Queen's Park. Time: 8 p. m., last Thursday of each month.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Lloyd B. Whitham, Mt. Vernon Pl. and Charles St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. John H. Bailey, 855 St. Marks Ave., Brooklyn.
Secretary-Treasurer: Dr. George Freiman, 703 Grand St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. H. H. Glosser, 448 Franklin St., Buffalo.
Secretary-Treasurer: Dr. I. J. Koenig, 40 North St., Buffalo.
Time: Second Thursday of each month.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. E. V. L. Brown, 122 S. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Thomas D. Allen, 122 S. Michigan Ave., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

CLEVELAND ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

CLEVELAND OPHTHALMOLOGICAL CLUB

Chairman: Dr. A. B. Bruner, 629 Euclid Ave., Cleveland.
Secretary: Dr. M. W. Jacoby, Hanna Bldg., Cleveland.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. John Milton Griscom, 2213 Walnut St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. W. C. Davis, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. M. Sage, 9 Buttles Ave., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. H. Newton, Mercantile Bldg., Dallas, Texas.
Secretary: Dr. Maxwell Thomas, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. C. C. Walker, 410 6th Ave., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Secretary-Treasurer: Dr. W. C. Mott, 214 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. T. L. Goodman, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John H. McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 307 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months. September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. R. M. Hargrove, 1202 Esperson Bldg., Houston, Texas.
Secretary: Dr. J. C. Dickson, 1617 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. H. McCaskey, 404 Continental Bank Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond E. Teall, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. A. W. McAlester, 2003 Bryant Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Clyde C. Harner, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul T. Southgate, 704 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. H. Brandt, 1136 W. Sixth St., Los Angeles.
Secretary-Treasurer: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd., Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. E. A. Leggett, 614 Breslin Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. E. Craddock, 604 Breslin Bldg., Louisville, Ky.
Place: Jewish Hospital. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. R. S. Pendexter, 900, 17th St., N. W., Washington.
Secretary: Dr. Lyman B. Tibbets, 1801 Eye St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. J. J. Brook, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Herbert G. Schmidt, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6 p. m., second Tuesday of each month.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Secretary: Dr. A. L. Guertin, 410 Sherbrooke St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Wesley Wilkerson, Bennie Dillon Bldg., Nashville, Tenn.
Secretary-Treasurer: Dr. Hale Cullom, Bennie Dillon Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Webb William Weeks, 20 E. 53d St., New York.
Secretary: Dr. Guernsey Frey, 121 E. 60th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. John H. Judd, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Robert H. Rasgorshek, 425 Aquila Court, Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Secretary: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward B. Heckel, 500 Penn Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

PITTSBURGH SLIT-LAMP SOCIETY

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Samuel M. Cottrell, 116 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Laurence Macey, 221 Alexander St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Meyer Wiener, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Frank Steed, Nix Professional Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Frank H. Rodin, 490 Post St., San Francisco.
Secretary: Dr. Louis F. Morrison, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. John T. Crebbin, 624 Travis St., Shreveport, La.
Secretary-Treasurer: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Marc Anthony, 422 Riverside Ave., Spokane, Wash.
Secretary: Dr. Raymond A. Lower, 1455 Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. D. F. Gillette, 109 S. Warren St., Syracuse, N. Y.
Secretary-Treasurer: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Clarence E. Hill, 160 Bloor St., West, Toronto.
Secretary: Dr. A. Lloyd Morgan, 86 Bloor St., West, Toronto.
Time: First Monday, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. William Thornwall Davis, 927 Farragut Sq., Washington, D. C.
Secretary-Treasurer: Dr. James N. Greear Jr., 1740 M St., N. W., Washington, D. C.
Place: Episcopal Eye and Ear Hospital. Time: 8 p. m., first Thursday in November, January, March and May.